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The Dock & Harbour Authority

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The Organisation with 3 Centuries of Dredging Experience

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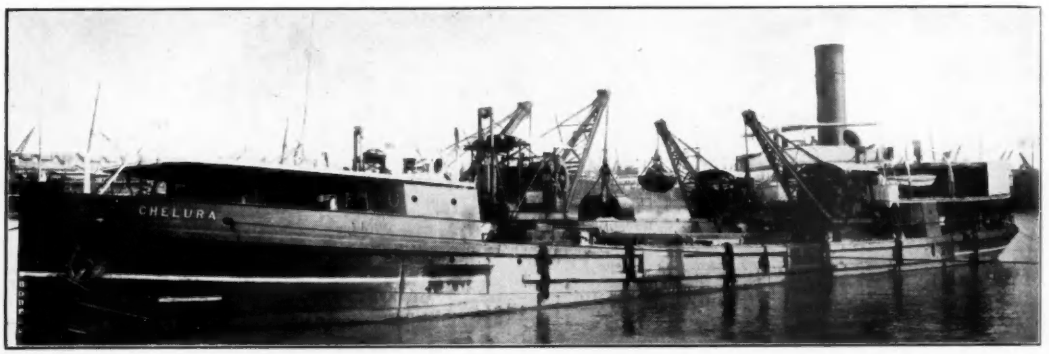
34-year-old "Priestman" is still the largest Grab-hopper Dredger in service

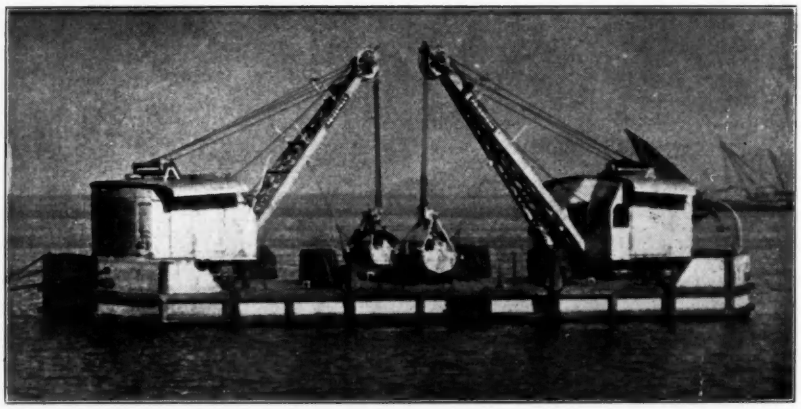
Bombay Port Trust specify "Priestman" on new Dredger



Thirty-four years may not, by comparison with the records of some venerable dredgers, be an exceptional life-span, but it is unusual in these days for the "world's largest" of anything to remain so for so long a period.

This is the record of the grab - hopper dredger "Chelura," fitted with four Priestman 3 - yard capacity grab dredging cranes, and owned by the Bombay Port Trust. After thirty-four years of monsoons, tropical heat, and all the difficulties which normally attend these conditions; the "Chelura" is not only still the "world's largest," but is every bit as efficient as she was in 1922.

After such a demonstration of reliability, it is hardly to be wondered that Priestman dredging cranes were specified when the Port Trust decided to purchase a further grab dredger.



The pontoon type dredger "Mayur" was built by The Mazagon Dock Ltd. at Bombay and has dimensions as follows:

Length	...	...	...	75-ft. 0-in.
Breadth	...	...	...	30-ft. 0-in.
Depth	...	...	...	8-ft. 0-in.
Draft	...	...	...	4-ft. 9-in.

It is arranged with a Priestman 2 cu. yd. dredging crane at each end with the necessary fuel and water tanks below decks amidships. Four winches for manoeuvring purposes are placed on deck amidships. In order to avoid damage to or from barges laid alongside the vessel is fitted with heavy fenders at deck and water level.

The two Diesel driven dredging cranes are of the Priestman No. 40 size, each arranged to operate with a total load of grab and contents of 4.4 tons at a maximum radius of 28-ft. from a jib of 31-ft. centres. The ropes are sufficiently long to allow the 2 cu. yd. grabs to be operated at a depth of 60-ft. below deck level.

The crane mechanism consists of separate power-operated drums on independent shafts and incorporates all those special Priestman features developed by their makers which have contributed so much to the successful operation of grab dredging equipment.

The Diesel engines develop 75 brake horse-power at 1200 revolutions per minute and are fitted with fluid couplings together with special oil coolers.

The mechanism and driver's platform are covered with a well-built steel house with large opening windows and shutters and a double roof with wide overhanging eaves. The driver thus has the maximum amount of protection from the elements and is not expected to sit in a partly exposed position under a sunshade roof.

The elimination of fatigue by well-designed controls and the provision of a comfortable driving seat leads to greater output per man-hour.

The dredger is for use in the docks at Bombay, where the spoil will be discharged into barges alongside and then towed out to be dumped in open water.

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SEPTEMBER, 1957

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Editorial Comments

The Port of Barry.

The fourth of our series of articles on the Ports of South Wales reviews the history and development of the Port of Barry and gives details of the present facilities and future improvement plans. In common with other ports comprising the Group, Barry initially owed her development to the exploitation of the nearby coal fields, and her prosperity was largely dependent upon the export of coal for both the coastwise trade and overseas. There was an appreciable decline in the years of depression in the 1930's but during the Second World War, owing to the devastation inflicted on many other ports in the United Kingdom, it became necessary, in order to prosecute the war, to instal much new equipment at Barry to enable the port to handle a wide variety of miscellaneous cargoes.

This improvement of the port's facilities has enabled a more balanced trade to be maintained during the post-war years and has offset to some extent the loss of her valuable coal export market—a loss which is emphasised by the fact that foreign coal is now included in the list of imports.

It is of interest to note that this year both imports and exports have shown some expansion. The latest figures available show that up to July 14th last imports have risen from 282,475 tons in 1956 to 314,272 tons, in spite of the decrease from 116,716 to 96,931 tons in the amount of foreign coal discharged. There have been increased imports of roadmaking and building materials, fruit and vegetables, foodstuffs, oil and spirits, iron and steel goods, pitwood, chemicals and general cargo. Exports have risen from 810,882 to 912,400 tons, and although foreign exports of coal and coke have declined from 156,926 to 140,328 tons there has been an increase from 600,682 to 695,796 tons sent to coastwise destinations. The port has also handled larger shipments of foodstuffs, vehicles, oil and spirits and general cargo.

These figures offer some encouragement but the port is not being used to capacity and there is still much potential available for the handling of general cargo. The new bulk cargo discharging berth and the provision of new cranes and ancillary equipment referred to in the article, which were recently authorised by the British Transport Commission, will still further increase the efficiency of the port and should be of considerable assistance in attracting further trade.

The Port of Georgetown Approach Channel.

The entry of all vessels to the Port of Georgetown, British Guiana, is governed by the depth of water on the bar and, over the years, difficulty has been experienced in deepening the approach channel to the port. This problem, which is common to all the Guianas (French, Dutch and British) is much the same as is found in the Mississippi, Orinoco and Bengal regions and generally is successfully overcome by costly dredging schemes, which the Guianas cannot afford at present. There is, however, an expanding bauxite industry and the shipping of ore deposits is being investigated. This could result in fairly large-scale dredging in time.

On a following page will be found a paper contributed by Capt. R. S. R. Mortimer, Harbour Master of the Port of Georgetown, in which he propounds the problems involved and suggests a method to improve the situation in the first instance. The paper, which is a combination of hydraulics, navigation and the problem of ship-loading draughts will be of particular interest to certain U.K. and American mining companies who are undertaking development exploration work in the Guianas.

Large Dry Docks.

We are privileged to be able to publish this month the first of our series of articles upon the design, construction and maintenance of modern dry docks. The author, E. L. Champness, is a Fellow of the North East Coast Institution of Engineers and Shipbuilders and writes from the point of view of the drydock owner. He discusses the all-important question of the dimensions to which a new dry dock should be built, and is of the opinion that the most recent drydocks constructed in Britain are below the width which current analyses might deem prudent for the future. He suggests that the entrance width should be the same as the dock width, as is the case at the new Refshaleöen dock of Burmeister & Wain Ltd.

The figures and tables emphasise very clearly how much modern drydocks suffer from obsolescence and give weight to the owner's view that the capital cost should be amortized over 25 years instead of the 50 years' period which exists today. The largest of the three new Tyne drydocks, that of Messrs. Swan Hunter & Wigham Richardson Ltd., was capable when designed of taking any ship in the British Merchant Marine with the exception of the two "Queens" and the "Mauretania," but today there are some seventeen U.K. vessels which are too large for this dock—which was actually designed to take aircraft carriers of the "Hermes" class and some of the 45,000 ton d.w. tankers. On the question of present upper limits of size, it is interesting to note that some large U.S. aircraft cariers have the phenomenal flying deck width of over 250-ft., and that loaded oil tankers are now leaving Kuwait drawing over 40-ft.

The drydock owner and constructor must carefully weigh the possible advances in ship's tonnage over the next 25 years and must consider whether to design for the docking of laden vessels or those damaged by storm, accident or enemy action. In this latter respect, the value of a dock sill draught at high water of at least 40-ft. cannot be overestimated. Mr. Champness suggests building a double-ended all-purpose dry dock of at least 1,100-ft. in length, having intermediate gates so that one, two or three vessels could be accommodated. He also gives some interesting suggestions upon the controlling of vessels entering and leaving dry dock by means of a system of blocks travelling along the side walls.

It is hoped that the lead given in Britain by private enterprise to the construction of new large docks will encourage public authorities to take advantage of the experience thus accrued and to build new dry docks for the future. It is both disappointing and surprising that whereas about one third of the dry dock capacity in Great Britain is owned by a public or dock and harbour authority, not one new large post-war drydock project has been undertaken by any of these bodies.

Editorial Comments—continued

Indian Ports and Maritime Problems.

The tenth anniversary of the establishment of India as an indepedent State was commemorated last month and it is interesting to review the developments which have taken place in her maritime industries during this decade.

When independence was attained ten years ago, the total of merchant shipping operated under the Indian flag was 125,000 gross tons; today the total is nearly half a million tons, and it is estimated that, by 1961, a total of 900,000 tons will have been reached. A considerable volume of new tonnage is under construction in foreign yards and the Hindustan shipyard at Vizagpatnam is working to full capacity. Because of the demand for additional shipbuilding facilities, the Indian Government proposes to build a second yard capable of building ships of over 10,000 tons and a mission is shortly to be sent to India, under the joint auspices of the Colombo Plan and the United Kingdom Shipbuilding Conference, to advise on the location and layout of the proposed yard, the equipment required and the overall capital cost.

Where the efficiency of her ports is concerned, however, the record is not so encouraging. Owing to lack of cargo handling facilities and the shortage of berths, India is experiencing serious congestion and delays in turn-round of shipping, chiefly because her major ports are not capable of dealing with the increased volume of trade resulting from efforts to industrialise her economy. This has involved large imports of iron and steel and heavy equipment in addition to food and consumer goods.

In order to deal with the problem of congestion, a meeting between the Overseas Shipowners' Consultative Committee and the Indian Ministry of Transport took place recently at New Delhi. This meeting approved a number of proposals, including plans for obtaining additional mechanised equipment to expedite cargo handling, increased use of lighters with the provision of more unloading points, the simplification of Customs procedures and the development of incentive schemes for dock workers. If these proposals are implemented, the result should be beneficial.

There have been many accounts in the press of port development plans and it is reported that an expenditure of £30 million—some estimates place the figure at £57 million—is to be allocated over the next five years to provide further port facilities. However, in view of India's present financial crisis and her unstable economy, these figures must be regarded with some scepticism—nevertheless, it does not appear that efficiency will be achieved until many costly improvement works are undertaken.

Progress on the St. Lawrence Seaway.

The third anniversary of the establishment of the St. Lawrence Seaway Authority was celebrated last month and, in the course of a special review to mark the occasion, Mr. Charles Gavsie, president of the Authority, stated that a thorough inspection of the progress of the work indicated that, if no major catastrophe occurs, the Seaway will be ready for shipping at the opening of the navigation season of 1959. The value of the contracts awarded to date is over $230 million, and some idea of the size and variety of the work involved can be gathered from the fact that the machinery and equipment required for the operation of the locks and movable spans totals nearly $20 million.

Since the construction works were started in November 1954, all the dredging contracts and the excavation and concreting contracts have been awarded, and a number have already been completed.

Last May the Canadian and U.S. authorities, who are jointly concerned with the building and subsequent operation of the Seaway, announced that the proposed schedule of tolls will be based partly on the cargoes carried in the ships using the Seaway, and partly on the carrying capacity of the vessels concerned. The schedule will be designed to cover the construction costs on a basis which will provide economical rates to Seaway users and also encourage traffic. It now appears that the waterway will be navigable by ships of larger size than had been estimated, the maximum overall length being 730-ft. and beam 75-ft. Care will be taken that the larger ships are not allowed to interfere with other traffic whenever their transit seems likely to involve undue delay. These maximum dimensions are based on the size of shipping that can pass through the deepened Welland Canal and the other canals and locks forming the Seaway.

Speaking in London recently, Lord Simon, president of the Chamber of Shipping, stated that it was a matter of fundamental importance that a toll structure should be evolved which would be simple in operation and also provide rates at a level which would attract traffic, and, in considering the method of levying and the level of dues, there was no ready precedent. The Seaway would not only provide a gateway to the heart of the American Continent but within the system itself, vast movements of cargo would continue to take place and develop.

For many years the annual volume of traffic through the Sault Locks connecting Lake Huron to Lake Superior has exceeded that of the Panama and Suez Canals combined. Although the locks are, strictly speaking, outside the actual Seaway system, this gives an indication of the magnitude of traffic moving in the whole area.

It is expected that the actual tolls to be charged will be announced this autumn and, although higher building costs and improvements made on the original plans are forcing up the original estimates, it is anticipated that the Seaway Project will be a paying proposition provided at least 50,000,000 tons of cargo are handled a year.

Canadian Regulations on Oil Pollution.

In view of the increased volume of shipping which will be using Canadian waters when the St. Lawrence Seaway is opened for navigation, it is interesting to note that on 1st July last, regulations for the prevention of oil pollution of Canadian water by ships came into effect for the first time. The new measures are the outcome of a detailed investigation carried out by the Department of Transport into a problem that has grown to serious proportions in recent years. Ships of every nationality must obey the regulations while they are in Canadian waters, inland or coastal, and a fine of up to $500 or imprisonment of up to six months, or both, may be incurred in cases of violation.

The new law, which covers only oil pollution from ships and not from other sources such as sewerage systems, industrial installations, etc., which come under Provincial and Municipal legislation, states that " no person shall discharge or allow to escape from a ship into the inland, minor or other waters of Canada, any oil or oily mixture that fouls the surface of the water," and defines such fouling as a mixture containing one hundred parts or more of oil in a million parts of the mixture. Exempted are bilge discharges containing only lubricating oil, emergency measures involving safety of life or property and accidental or unavoidable leakage. Where oil has been discharged for either of the latter two reasons, the shipmaster is required to inform the Department of Transport.

All ships of Canadian registry as well as other ships engaged in the coastwise trade of Canada must now carry an oil record book to assist preventive officers in their work. Enforcement of these regulations will be carried out by special officers appointed by the Department of Transport. The aid of harbour authorities throughout the country is also being enlisted.

Conference on Coastal Engineering.

It has been announced that the Sixth International Conference on Coastal Engineering is to be held at Florida from 2nd to 7th December next. The Joint Sponsors of the Conference are the College of Engineering of the University of California and the United States Council on Wave Research, which was established under the Engineering Foundation, New York City, in 1950 to encourage, co-ordinate, and sponsor research in coastal engineering.

International conferences on coastal engineering, organised by the Council, have attracted coastal engineers from all parts of the world and have contributed materially in drawing attention to this vital field of engineering. The fifth international conference was held at Grenoble, France, in 1954.

It is appropriate that this year's conference should be held in Florida, as it was just two years ago that an intensive programme of study began on the coastal engineering problems of that state. Since that time the coastal authorities in Florida have become increasingly aware of the value of qualified engineering advice in coping with the problems of beach and harbour erosion.

The Ports of South Wales

4. The History and Development of Barry

(Specially Contributed)

The growth of Barry as a town and seaport dates back to the opening of the No. 1 Dock in 1889, and is a striking example of the speed of industrial development in South Wales during the second half of the nineteenth and the first decade of the twentieth century. To appreciate the conditions which led to such rapid advance from a small hamlet with a population of a few hundred to a town of approximately 40,000 inhabitants over a period of about twenty years, it is necessary to review the development of the South Wales Coalfield and the growth of the coal export trade prior to 1889.

Before 1836, coal mining in South Wales had been merely an adjunct to the principal industry of iron smelting, but in that year the Merthyr and Aberdare Valleys began to be worked seriously for the production of coal, and it was not long before knowledge of the excellent qualities possessed by Welsh coal had extended beyond South Wales and created an overseas demand which led to the development of a coal export trade.

Facilities for the transport of coal from the Valleys to the sea were practically non-existent at that time, with the exception of the Glamorganshire Canal and the River Taff. The Canal was constructed from Merthyr to Cardiff in 1790 and used largely for the conveyance of iron to the coast. Lord Bute had obtained Parliamentary powers in 1830 to make a ship canal near the mouth of the River Taff and also to construct a dock at its termination for shipping coal. Apart from the making of a narrow entrance channel, the ship canal was not proceeded with, but the Bute West Dock, Cardiff, was built and opened in 1839.

As the years passed, so the Coalfields of South Wales and Monmouthshire continued their rapid development and the ever-present problem was the lack of sufficient dock accommodation to cope with the expanding export trade. The building of the Bute East Dock, Cardiff, and also Penarth Harbour was completed in 1859 and in 1865/6 further powers were obtained to construct Penarth Dock and the Cardiff Roath Basin.

The overseas demand for Welsh coal continued to increase rapidly and by 1882 both Cardiff and Penarth Docks were extremely congested with shipping, with the result that vessels often had to wait several days before coaling appliances were available. To meet this position Lord Bute obtained the approval of Parliament to construct a new dock at Cardiff, extending eastwards from the Roath Basin and, at the same time, Parliamentary approval was given for an additional charge of 1d. per ton to be levied on the shipment of coal, not only at the new dock, but also at the then existing docks at that port. This additional charge of 1d. per ton was strenuously opposed by the local Coal Freighters, who stated in their opposition to the Bill before the House of Commons Committee that they were prepared to undertake the construction of whatever further dock accommodation was necessary, at their own expense, rather than pay the increased rates.

Following Parliamentary approval of the proposals of Lord Bute, the Coal Freighters held a meeting on the 23rd June, 1882, in the offices of the Ocean Coal Company at Cardiff, when it was decided to investigate the possibility of constructing a new dock, and an Engineer was appointed to report upon the most suitable site for this purpose on the northern side of the Bristol Channel. The Engineer's report favoured two sites, one at Barry, approximately eight miles to the westward of Cardiff, and one at the mouth of the River Ogmore, approximately twenty miles further west, and after careful consideration had been given to both these sites it was decided to proceed with the construction of a dock between the mainland and Barry Island. On the 30th November, 1882, the Parliamentary Plans and details of the proposed undertaking were deposited, and the first Bill to promote Barry Docks was before the House of Commons in 1883. This Bill met with considerable opposition and, although the preamble was passed by the House of Commons Committee, the House of Lords Committee threw out the Bill in July, 1883.

The congestion at Cardiff and Penarth showed no sign of lessening, and the promoters of the Barry Docks Bill made a second and successful attempt in 1884, the Bill being passed by Parliament on 31st July of that year. The promoters had already incurred Parliamentary costs of £160,000, but no difficulty was experienced in raising the necessary capital for the construction of the new dock, and tenders were invited for the work. The successful contractor was Mr. T. E. Walker, whose tender of just under £600,000 was accepted, covering the construction of a 40-acre dock, with an 8-acre basin and entrance lock, on a site to be reclaimed from the tidal channel between Barry Island and the mainland, and having in connection therewith about 7 miles of railway with a considerable mileage of sidings for marshalling and storage purposes.

Construction of Barry Docks

The cutting of the first sod of the new dock was performed by the Right Honourable the Lord Windsor, Chairman of the new Company, on the 14th November, 1884, at a point where the Dock Offices now stand.

Although Barry was physically and geographically well suited for the construction of a new dock, its isolated position presented considerable difficulties in the conveyance of plant and materials and the housing of the large number of men required for this great undertaking.

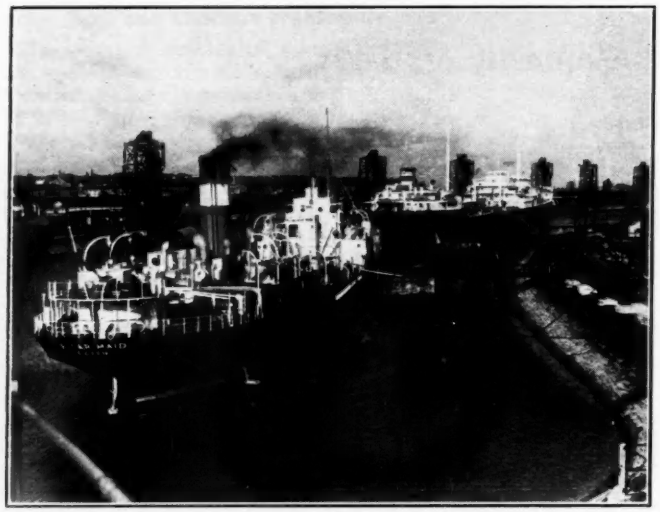
The only means of communication between Cardiff and Barry were narrow country lanes, for the most part only about 10 feet in width, with several gradients of one in six. The hauling of all the large quantities of materials required through these lanes was not, therefore, a practicable proposition, and the first active measures taken were to provide alternative means of transport. The contractor first proposed to construct a temporary railway from Penarth Dock to Barry, but was unable to do so as the line would have to pass over certain lands belonging to Lord Bute, who was, of course, in active opposition to the construction of the new dock. Failing the provision of a temporary railway the contractor constructed a pier in Barry Harbour at which materials were received from coasting vessels, and a traction engine was purchased to haul materials by road from the Penarth Dock Station. By these means, and by the use of a number of horses, the required materials were conveyed to the site.

The first operations to be undertaken in the actual work of construction were the making of three dams for the exclusion of tidal water from the site of the dock. These embraced a dam at the western end and an intermediate dam, across the proposed entrance lock, these two enclosing the dock proper; and a third dam enclosing the basin ; the latter being the most easterly of the three. To obtain the material required for the construction of these dams, efforts were concentrated on the excavations necessary for the making of the 7 miles of railways authorised by the 1884 Bill, which were to connect Barry Docks with the railways already serving the Rhondda and Rhymney Valleys.

Some 3,000 men were eventually engaged on the work, and at the outset great difficulty was experienced in finding accommodation for this labour force.

In consequence large numbers of the men walked each morning a distance of 8 miles from Cardiff, returning at night : Scores of wooden huts were subsequently built at Barry Island and the contractor also leased about 30 acres of land at East Barry where, in a month or so, he started to erect the masonry dwellings which later constituted part of the town of Barry. Shops were also built for supplying the men with provisions, etc., and negotiations

Ports of South Wales—continued



Whaling vessels discharging whale oil to tanks, Barry Docks.

entered into with the Postal Authorities for the establishment of a postal service and telegraph office, the working expenses of these services being guaranteed by the Contractor.

Work on the building of the dams proved long and arduous, the western dam being particularly troublesome, owing to the unstable nature of the ground. Unsuccessful attempts were made at low tide to close the gap with soil alone but, although every effort was made to do so before the return of the tide, the material forming the dam was repeatedly washed away. It was then decided to revert to the original idea of closing the gap by dropping down timber shutters and backing up with soil as rapidly as possible. This method proved successful and the dam was closed and tidal water finally excluded in March, 1886. No difficulty had been experienced with the other dams, which were closed in July, 1885.

The entrance to the dock, protected naturally on the west by a jutting portion of the island called Nells Point, was further protected by the construction of two breakwaters, the eastern one being 2,600 feet in length and that on the western side 700 feet, the width between the breakwater heads being 350 feet.

Many and various were the alterations made in the plans upon which the contract for the construction of the dock was based and the original proposal for a water area of 40 acres was increased to 73 acres in the final plans drawn up by the Engineers Mr. J. Wolfe Barry and Mr. H. M. Brunel, and the dock was built to these dimensions.

From the cutting of the first sod to the opening of the dock (1884/1889) the constant vigilance of the Directors and the energy they infused into the Contractors kept things moving at a fast rate. All minor difficulties, inseparable from such a large project, were promptly tackled and disposed of, and July 18th, 1889, saw the culmination of this great commercial enterprise when the dock and basin were formally opened.

The dimensions of the dock and basin, which still apply to-day, are as follows :—

Length of Dock	3,100 ft.
Width of Dock	1,100 ft.
Length of Basin	600 ft.
Width of Basin	500 ft.
Water area of Dock	73 acres
Water area of Basin	7 acres
Quayage of Dock	14,560 ft.
Quayage of Basin	2,040 ft.
Width of Sea Lock (Basin) ...	80 ft.
Average depth on outer cill (Basin)	
H.W.O.S.T.	36½ ft.
H.W.O.N.T.	28 ft.

The new Dock was designed mainly for the shipment of coal and 29 hoists were provided for this purpose. The basin was equipped with hydraulic cranes to handle timber cargoes and deal with a small general cargo trade. It was estimated that shipments of coal would approximate 2,000,000 tons per annum, but in 1890 the first full year the Docks were open—more than 3,000,000 tons of coal and coke were shipped and by 1897 the annual exports had risen to nearly 6,000,000 tons.

This rapid growth in the volume of trade at the port led to the Board seeking further Parliamentary powers to construct an additional dock at Barry, and it is interesting to note that this was the only occasion upon which a Barry Bill for the construction of works was unopposed in Parliament.

A new dock was authorised in 1893 and building commenced in 1894, the dock being completed and opened for traffic in October, 1898. It lies to the east of the original dock, from which it is approached by a passage, originally closed by a rolling caisson, which has since been removed and a swingbridge substituted.

The dimensions of the dock are as under :—

Length	3,320 ft.
Width	400/600 ft.
Quayage	7,430 ft.
Deep Water area	34 acres
Normal depth of water	32 ft.

During the same period the facilities of the Port were greatly improved by the construction of a deep water lock, officially known as the Lady Windsor Lock. It had been the intention of the Board from the outset to construct such a lock and in April, 1893, Lord Windsor laid the foundation stone. Mr. J. Jackson, of Westminster, secured the contract for the excavation and the erection of masonry, the cost being £309,000. The lock took nearly five years to build and was opened to traffic in January, 1898.

The lock enabled small ships to enter or leave the dock at practically any state of the tide, while large vessels were only held up for a few hours.

The lock has the following dimensions :—

Length	647 ft.
Width	65 ft.
Average depth on outer cill—	
H.W.O.S.T.	48½ ft.
H.W.O.N.T.	40 ft.

The opening of the new dock completed the present dock system at Barry, which comprises a total area of 114 acres of enclosed deep water in which an average depth of 32 feet is always maintained. Quayage totals nearly 20,000 linear feet. The original dock and basin are known as Nos. 1 and 3 Docks respectively, whilst the new dock is called No. 2 Dock. No. 3 Dock was the

General cargo destined to Persian Gulf being loaded at Barry Docks.

Ports of South Wales—continued

original entrance and is still available as an alternative to the Lady Windsor Lock.

Unlike No. 1 Dock, facilities for the shipment of coal were concentrated on the north side only of No. 2 Dock, where 12 coal hoists were erected to deal with this traffic. The south and west sides of the dock, with quayage of 3,600 linear feet, were laid out to handle the import and export of general merchandise, whilst transit sheds, cold stores and hydraulic cranes were installed for handling this class of trade.

An amazing prosperity developed in the years that followed the opening of No. 2 Dock. In 1901 the coal and coke shipments from Barry Docks exceeded those from the Bute Docks, Cardiff; Barry exporting 7,800,000 tons against the Cardiff figures of 7,200,000, and Barry rose to the supreme position in the coal exporting trade amongst the Bristol Channel Ports.

The peak figure was reached in the year 1913, when Barry exported more than 11,000,000 tons, thus creating a record which, it is safe to say, will never again be reached.

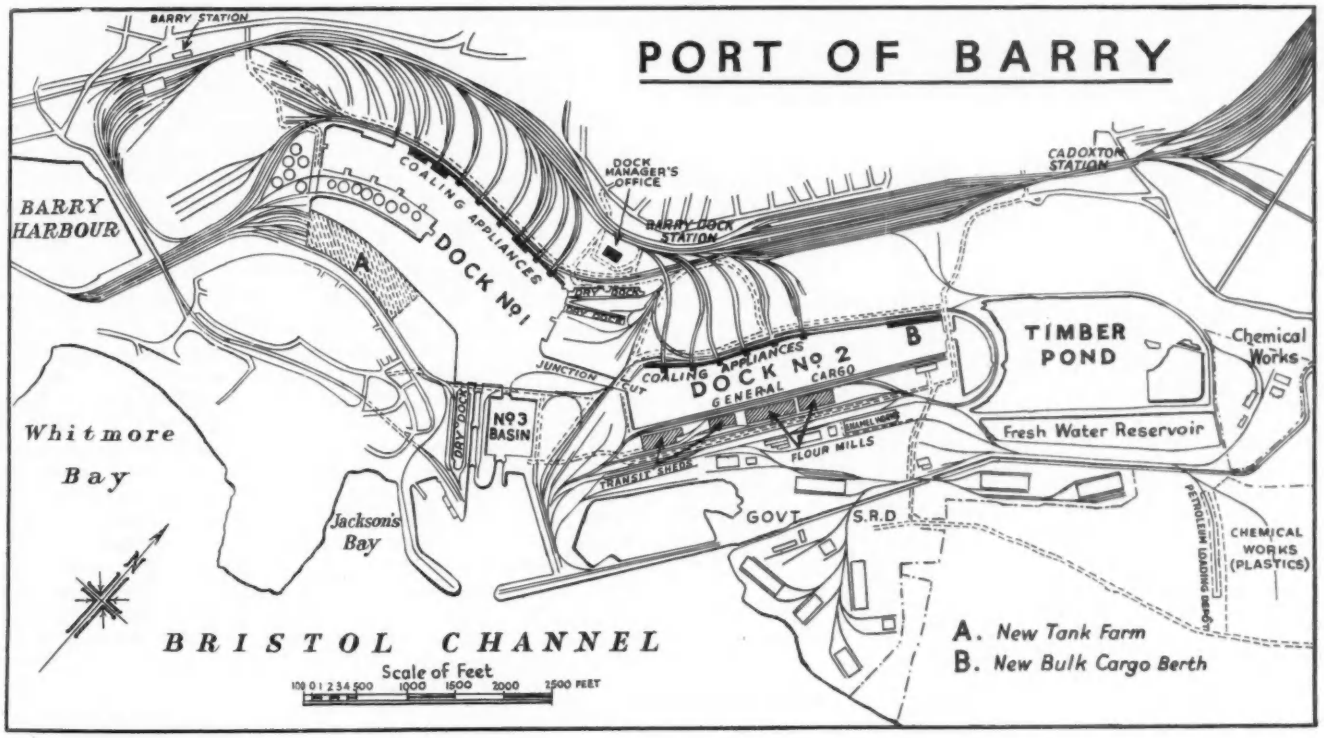
The 1914/18 World War foreshadowed the beginning of the end of the prosperous coal exporting years in South Wales and valuable overseas markets which were lost during that period were never fully recaptured. This factor, allied to the industrial depression which hit this country and other parts of the world in the 1920's and continued into the early 1930's was responsible for a yearly fall in coal and coke exports, and although the decline was gradual, the long-term effect is exemplified in the figures for coal exports from Barry in the year 1938, which were 5½ million tons compared with the 11 million tons shipped in 1913.

During the second World War, Barry, in common with the other ports in the South Wales Group, was called upon to deal with a great variety of general cargo, the number of Transport Workers employed on this class of work increasing by five times the normal register. The peace-time trade of coal, mining timber, cement, etc., almost disappeared, and the Port was involved in handling every type of commodity needed to maintain the Armed Forces and the civilian population. However, this period of change in the character of the Port's trade did not impair its post-war efficiency and the improvements in accommodation and equipment provided to handle the vast tonnages of miscellaneous traffics dealt with during war-time, remained with the Port to assist in the task of rebuilding an economic peace-time trade.

Changes in Administration

The Port has experienced two changes in administration during its lifetime. The first was consequent upon the passing of the Railways Act of 1921, when the multifarious Railway Companies throughout the country were amalgamated into four groups. The Great Western Railway Company maintained its identity and absorbed all the major railways and railway-owned docks in its region, the Old Barry Railway Company thus ceasing to exist.

The new owners did much to improve the dock facilities during their tenure; a more powerful electricity supply was introduced, additional lighting installed, new coal hoists were erected to cater for 20-ton coal wagons, a 50-ton Floating Crane was based at the Port, modern electric quayside cranes were provided, and digging-out appliances were provided at certain coal hoists for clearing wagons of duff and small coal.



The whole of the hydraulic plant power at the Port was electrified, new lock gates were installed and a new swingbridge was provided in place of the old caisson at the Junction Cut between Nos. 1 and 2 Docks. In 1930 a new supply of fresh water of the highest purity was brought into use at Barry Docks by arrangement with the Barry Urban District Council and the Taff Fechan Water Board.

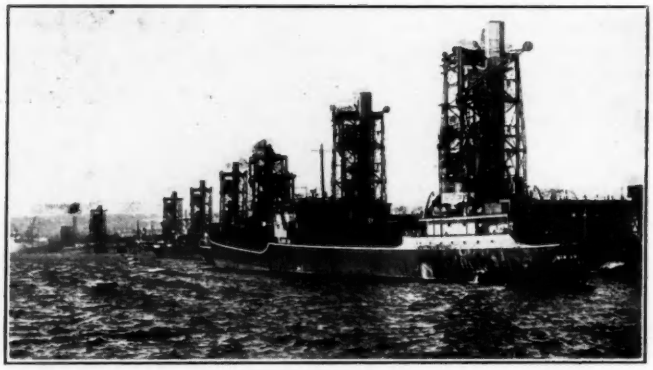
The second change of ownership occurred in 1948, with the nationalisation of the railways and railway-owned docks of the country, and Barry Docks, in common with the other South Wales Ports, thereupon became vested in public ownership, and is to-day managed by the Docks Division of the British Transport Commission.

THE PORT TO-DAY

One of the chief natural advantages of Barry Docks is the close proximity of deep water, which enables the easy and economic

Ports of South Wales—continued

maintenance of an ample depth of water in the approach channels to the Lady Windsor Lock and the basin entrance. The employment of a modern bucket dredger and attendant hoppers for the removal of some 200,000 cubic yards of silt each year is sufficient to meet the requirements of modern cargo liners and oil tankers visiting the port.



Vessels loading coal at No. 1 Dock, Barry.

Because of the great range of tide in the Bristol Channel, dredging has to be carried out on a tidal basis, and accommodation is provided for the crews who live aboard the craft engaged in this work. V.H.F. radio communication operates between the dredging craft and the shore.

No. 1 Dock

On the north side of this dock—which has a water area of 73 acres—are situated coaling hoists, while at the western end Messrs. Cory Bros. & Co. have taken over an oil tank farm, constructed by the Ministry of Works just prior to the war. Messrs. Cory Brothers have erected further tanks in this area and storage accommodation is now available for 135,000 tons of oil of various descriptions. A Mole, 1,300 ft. long, projects into the Dock at this point, and affords berthing facilities at which tankers may discharge cargoes of diesel oil, fuel oil, whale oil and vegetable oils direct to the tanks, while bunker oil can also be supplied direct from the tanks to the vessels. The firm have taken over a further area of land on the south side of No. 1 Dock and work has commenced on the erection of additional oil tanks which will have a total capacity of 150,000 tons.

Two berths are also available at this dock for the repairing of vessels afloat, and accommodation is provided for several large vessels to moor at the buoys in the centre of the dock.

No. 2 Dock

Whilst most of the north side of this dock is equipped with coaling appliances, the Commission have recently authorised the expenditure of £265,000 to provide a new bulk cargo discharging berth on this side of the dock. The new berth will be 570 feet long and equipped with five electric cranes of 10 tons capacity, fitted with grabs to deal with bulk dry cargoes such as coal, scrap iron, ores, etc. The cranes will have a radius of 70 feet and will be able to load direct to rail trucks on five lines to be installed on the quay, the surface of which will be flushed in concrete to provide easy access for road vehicles.

On the south side of the dock are situated the large flour mills, silos and warehouse of Messrs. Joseph Rank, Limited, who established their business at the port in 1905. The firm's loading and discharging berth is equipped with elevators and conveyors for discharging grain direct to the silos and for loading over side, approximately 150,000 tons of grain being dealt with annually.

The remainder of the south side, which has a total length of 3,500 feet of straight quay, is equipped with modern electric quayside cranes of three- and six-ton capacity to deal with all types of general cargo.

Two transit sheds are available with a total floor area of 84,825 square feet, both equipped with fork lift trucks and mobile cranes, while calf-dozers have been introduced recently to facilitate the discharge of bulk cargoes such as imported coal. The calf-dozers operate aboard vessels, in the 'tween decks or holds, and push the cargo to the square of the hatch, thus obviating much of the laborious hand shovelling which was formerly necessary.

To the south and east of the general cargo quay is located a large Government Supply Reserve Depot, from which considerable quantities of stores and ammunition are sent to our troops overseas. On an adjoining site Messrs. Fellows Chamberlin, Limited, have established an extensive factory producing enamel hollow-ware of all descriptions.

To the east of No. 2 Dock are located the large factories of Distillers Ltd., operated by their subsidiary Companies, British Geon Ltd., British Resin Products Ltd., and Distrene Ltd. These companies engage in the research and manufacture of plastic bases, and import quantities of resin and chemicals through Barry Docks.

In close proximity to Distillers' factory is another large chemical installation operated by Midland Silicones Limited.

No. 3 Dock or Basin

As previously stated the Basin formed the original entrance to the Docks and is still used as an alternative entrance. On the eastern side, adjacent to the quay, Messrs. Meggitt & Jones Ltd., have operated a timber importing business since 1903. Sawmills, workshops and stacking yards are in use, and the quay is equipped with five cranes for the discharge of timber cargoes direct to rail or to the firm's yards.

On the north side of the Basin, Messrs. F. Bowles & Son Limited, import sand and gravel for building purposes.

Drydocks

After the last war, developments in marine architecture, especially in oil tankers, tended towards vessels of much greater length and beam; so much so that it became increasingly difficult for the Ship Repairers at Barry Docks to accommodate the large craft which they were being offered. This situation resulted in Messrs. C. H. Bailey Limited, entering into a long-term lease of the Commercial Dry Dock, owned by the B.T.C., and spending a large sum of money on its expansion. The firm carried out extensive alterations to the dry-dock, which was lengthened to 940 feet and the entrance widened to 78 feet 6 inches, and this fine dry-dock is now the largest on the South Wales seaboard. The firm also have 3 Wet Repair Berths available and a modern tank cleaning and oil sludge disposal unit for cleaning tankers after discharge.

General Cargo Berths at Barry.

Other dry dock facilities at the Port are provided by the Barry Graving Dock and Engineering Company, who have the following docks available, in addition to a Wet Repair Berth:

Graving Dock No. 1. Length 795 ft. Width of Entrance 55 ft.
Graving Dock No. 2. Length 620 ft. Width of Entrance 66 ft.

Ports of South Wales—continued

Electrification Schemes

Whilst until recently the South Wales Ports in general have generated hydraulic power with steam as the prime mover, the hydraulic stations at Barry Docks were modernised and electrified in 1931 and the electrical supply at the Docks was by means of a 3,300-volt ring main service installed in 1926. This was supplemented in 1931 by two 11,000-volt radial feeders from the supply point to cater for the then new power stations. One of these power stations has since been made fully automatic, the pumps being controlled by means of tappet switches fitted to the station's hydraulic accumulator.

The Impounding Station was electrified in 1940 and is supplied from the same electrical ring main system. This system has looked after both Tenants and Commission's requirements through fifteen sub-stations positioned at the load centres around the Docks.

Whilst this has been adequate so far as loading is concerned, the switchgear design is such that it is not capable of handling the currents which can be expected under fault conditions with the present generation capacity of the Supply Authority, neither is it suitable for any increase in loading.

A scheme has, therefore, been prepared and installation will shortly commence, for a complete new ring main system at 11,000 volts. There will be, in all, thirteen distribution points around the ring, including four new sub-stations to be situated in areas at present not suitably covered.

One of these new substations is being provided to cater for the five new 10-ton dual purpose electric quayside cranes previously mentioned as being installed at the new bulk discharge berth on the North Side of No. 2 Dock.

The electricity supply, which will be at 415 volt, 3 phase, A.C., is arranged through a ground plug service employing Walsall type watertight plugs having a capacity of 300 amps.

Three outlying sub-stations, at present fed from the ring main system will, for economical reasons, be supplied independently by the South Wales Electricity Board at 415 volts, 3 phase 50 cycle, these points being used for the control and distribution of the supplies in their area.

Future prospects

Although the port has suffered severely from the decline in coal exports, the British Transport Commission, ably supported by the Local Authorities, are actively pursuing every possibility of developing the general cargo trade, and there is good reason to anticipate that the excellent facilities available and their continued improvement will eventually bring about a return of much of the prosperity previously enjoyed by Barry Docks.

Erratum

In the article on the Port of Newport which appeared in our August issue, we regret that there was a serious error in the sketch plan of the Port. The South Quay, South Dock, and the East Side of the North Dock are shown as being equipped with coaling appliances. In fact, however, both these Quays are used and equipped for General Cargo.

Cargo Handling and Ship Design

Modern Methods Require Modified Construction

By E. S. TOOTH

Much discussion occurs about how ships should be designed to meet the requirements of modern cargo handling methods. Before this question can be answered, however, it is necessary to consider what modern cargo handling methods really are.

Most people connected with the port industry will agree that there is a growing tendency to consign cargo where possible (a) in bulk or (b) in large "packages" which are, for practical purposes, unit loads in one form or another. This article, it should be stated now, is not a technical one on ship design; it is an attempt to obtain a clear picture of what is required in new general cargo vessels so that the work of loading and discharging can proceed quickly and safely.

Bulk Carriers.

More and more commodities, liquid and solid, are being carried in bulk and perhaps one of the most interesting new ones is unrefined sugar. This traffic is only seven or eight years old and, when it began, bulk sugar was loaded only into conventional cargo vessels, with 'tween decks, alleyways, tanks, hold ladders, sounding pipes, propeller shaft tunnels and sometimes even stanchions. Discharge by grab—which is still the speediest method—was therefore slow and difficult and often resulted in much damage to hold fittings. Moreover, because of the obstructions mentioned, machines and men were always required to trim the cargo to places accessible to the grab.

As the quantity of sugar shipped in bulk increased at the expense of that bagged, consideration was given to the need to build bulk sugar carriers. The pattern of "simple" bulk carriers was followed, i.e. the new vessels were "general" ships and not of the kind designed for a special and regular trade, where, for instance, the discharging appliances, e.g. mechanically operated hold outlets and conveyors, are incorporated in the design of the vessel.

The simple aim when constructing modern "general" bulk carriers is to make them self-trimming and the method which has been employed in the sugar trade is to construct the ship so that each hold has (a) large hatchways, (b) smooth sides, with no cleats, ledges or any kind of fitting upon which sugar can rest or cake and which (c) incline towards the bottom of the hold so that the whole of the ceiling is within easy reach of the grab. One means employed to achieve this kind of hold construction has been to place tanks for liquid cargoes on the port and starboard sides of each open hold, except, perhaps, No. 1. The effect of this is that only a small portion of the hold is under the main deck and all of the ceiling of the hold is underneath the square of the hatch. There are, of course, no 'tween decks in these vessels and since the engines are usually placed right aft, there are no propeller shaft tunnels to interfere with cargo working.

Despite this type of construction, however, some trimming is still required if the speediest discharge is to be obtained. This is because some commodities (and sugar is one of them) will, in some conditions, adhere here and there to even smooth bulkheads and sides, creating a need for labour (usually only one man) to brush or scrape as discharge proceeds; and also because, although the grab has access to the whole area of the ceiling, a time arrives when it cannot pick up a reasonable load unless the cargo is heaped for it. When the ceiling is reached, therefore, a machine or four or five men may be required for trimming.

General Cargo Vessels.

As already indicated, the need for bulk carriers is established and is being met. Many such vessels are now in use and others are in course of construction. The need for unit load carriers, however, is not yet even established, although special ships have been built to carry cargo in load form. An example of these is the trailer-ship, which was the subject of an article in the June issue of this Journal. This vessel is part of the system of transporting loaded road trailers and railway wagons and it cannot by any stretch of imagination be called the kind of vessel with which we are at present concerned, viz. the general cargo vessel.

The term "unit load" is usually taken to mean a number of separate packages strapped into a unit of suitable size and shape for mechanical handling. Such a load is usually but not always palletised. In its broadest sense, the term might include containers, but it does not include trailer loads.

The tendency to ship goods in unit load form, with or without pallets, is already apparent, but this method is developing very slowly. Nevertheless, that it will continue to develop and will ultimately effect a big percentage of ships' cargoes seems certain.

In attempting to assess what new features are needed in newly-constructed general cargo vessels, it is necessary, as already stated

Cargo Handling and Ship Design—continued

to consider recent developments in cargo-handling methods. These stem from two sources — (1) the availability of new types of machines and (2) the development of new ways of packing goods for transport across the world.

In practice, these two factors are very closely related, because the primary machine which is changing handling methods in many world ports—the fork-lift truck—is also the machine which has been responsible for the introduction of the unit load method of materials handling into general industry. The fork-lift truck can convey and stack, provided the goods are made up into suitable loads—and one of the main points made in its favour (at present somewhat academically) is that, if goods are " suitably " packed in unit loads (instead of being moved as separate packages), the fork truck can handle them at every point of movement from home factory to receiver's premises across the seas. Thus the unit load method is often called " the throughout movement method."

Unit load handling equipment. Goods on a 48-in. x 72-in. pallet being loaded into a barge at Amsterdam by means of a quay crane fitted with a pallet " hook."

" Fork-Lift Truck " Traffic.

At this point it is useful to examine what is meant by goods being " suitably packed " for handling by fork-lift truck.

At first, most loads handled by fork trucks were palletised, usually on the type of pallet which permitted loads to be stacked. Sometimes pallets were expendable but more often they were made strong enough to make a considerable number of journeys—often posing a " returned empty " problem! At the present time, the variety of kinds of pallets is large and the range of " permanent " types blends into that of the " expendables " and the range of expendables into various kinds of underside bearers and battens. To give examples of the whole range seen in ships' cargoes, there are (a) neat unit loads of cased goods on substantial double-deck reversible pallets, (b) bales of paper on light single-deck pallets, (c) goods, from cartons to steel plates, on expendable pallets, (d) cargo, such as wallboards, where the bottom sheet, with suitable bearers, forms the pallet, (e) cargo, such as metal concentrates, with the expendable pallet made of the material itself, (f) packages or cases with special bearers so that the bottom of the case itself is equivalent to the pallet deck and (g) cases (e.g. of machinery) with battens thick enough to allow the fork truck to pick them up. There are also, of course, loose and soft goods in various types of box pallets.

However, these are not the only kinds of loads which the fork-lift truck can handle. There are the palletless unit loads (e.g. of metal ingots) so built that there are apertures for the prongs of the fork; the cylindrical packages, such as drums of oil and reels of linerboard; the bundles of wire, coils of rope and rubber tyres; the sets of timber stowed on dunnage; and the pieces of machinery, girders and so forth which, with a little ingenuity, can be picked up direct from the ground or from the floor of a vehicle. Moreover, with special attachments, the fork truck can extend the range of its work still further. It can, in fact, lift, convey, turn, invert and rotate loads and even pour from containers. It is not surprising, therefore, that port operators, as well as manufacturers, distributors and transporters, are beginning to plan much of their work around it.

A most important result of its introduction into general industry has been to bring about the development of the unit load method of handling. The employment of pallets has made necessary (a) changes of the design of road and rail vehicles, (b) alterations in packaging methods and (c) the construction of a new type of depot and warehouse, in which the dimensions of each floor or division are multiples of the dimensions of the unit load it is intended to store in it. More and more unit load traffic is appearing in all the five continents. In this country, British Railways are already carrying over 300,000 tons a year, practically all in pallets. Thus, it is reasonable to expect that sooner or later, unit load traffic will penetrate international shipping lanes and with this probability in mind the International Organisation for Standardisation has been working on and has nearly completed an international standard for " pallets for the unit load method of materials handling." Many countries, of course, already have their own national standards.

Shipowners and unit load traffic.

Port Authorities (in premises design and facilities) and Master Stevedores and other employers of labour (in handling equipment and methods) have already had to take note of these new developments, which are, in fact, always carefully watched by organisations concerned with increasing cargo-handling efficiency and ship and vehicle turn-round time. For example, the Maritime Cargo Transportation Conference of the U.S. National Academy of Sciences, in a recent study of " Cargo Ship Loading " (see the August issue of this Journal) stated (1) that promise of a significantly greater improvement in productivity can come only from new systems which eliminate the current break-bulk process (i.e. package-by-package handling) in the hold, and (2) that when the hook ceases to be a bottleneck, loading productivity can be increased significantly by developing and utilising mechanical devices which accelerate stowing operations and reduce fatigue in the hold. Time would also be saved, it is added, if changes were made in ship design to make wing stowages more accessible. Shipowners have long been concerned with this matter, particularly since palletised cargo can affect them in two different ways. Handling unit loads may save loading and discharging time; the pallets may waste valuable freight space.

Many shipowners have given this matter much thought especially since the employment of dock-tool pallets (i.e. those which never travel out of the port, either landwards or seawards) has shown the potentialities of the new method. In some places where these have been introduced (in the London docks, for example) ship-loading speed has been increased by over 20% (deadweight tonnage) and shed capacity has been more than doubled. At present, the quantity of pre-palletised traffic being carried in deep sea vessels is very small but there can be no reasonable doubt that it will grow as time goes on. Certainly there will be a considerable increase in the kind of cargo sometimes called " fork-lift truck traffic," of which unit loads are only a part. If this cargo is to be handled and stowed in ship satisfactorily, it is also certain that changes must be made in the design of the present-day conventional cargo vessel.

What sort of changes are these? The answer cannot be a dogmatic one and the following suggestions, which are to some extent deductions, are thrown into the pool for discussion.

Features in New Vessels.

In order to deal with unit load or other " fork truck " traffic aboard ship, it is necessary to get pallet trucks and fork-lift trucks into the holds. Taking a long view, if the needs of modern quay cranes and ships' purchases are to be served adequately, one must be prepared for unit loads weighing up to 3 tons. A fork-lift truck capable of handling 3 tons weighs about 11,000 lbs.; thus

Cargo Handling and Ship Design—continued

it is reasonable to say that at least at those holds designed for mechanical handling, the derricks or cranes on the ship should have a capacity of 5 tons.

Having got the machine aboard, it must have suitable conditions in which to work. First, there must be no restrictions in its running area. That implies flush 'tween decks (i.e. no hatch-coamings), substantial (probably metal) hatch coverings and no cleats, trimming hatches, stanchions, alleyways or holes and corners such as are still found in many general cargo vessels. It also implies a level and horizontal ceiling, because one important safety need in fork truck operation is that the machine shall not have to work on an appreciable incline.

A further need for satisfactory stowing of unit loads is vertical hold sides; otherwise, unless loose cargo is used for "chocking off," a safe stowage will not be made easily. The safe stowage of unit load traffic is, indeed, a matter which requires keen attention.

For various reasons—the aesthetic being only a minor one—curves and not straight lines are a feature of ship design. Nevertheless, it is obvious that this preliminary investigation is revealing a need to make holds into large boxes. It is obvious, too, that unless much freight space is to be lost, this cannot be achieved at every hold. It may be considered worth while, therefore, as an interim development, to concentrate on the holds which most lend themselves to this kind of construction. In a five-hold vessel these are likely to be Nos. 3 and 4, together with that part of No. 2 hold not affected by the flare of the ship's bow; thus Nos. 1 and 5 holds and probably the forward end of No. 2 hold would be allocated to the big percentage of cargo which, for many years, will be shipped loose. All holds, it is thought, should have flush 'tween decks but unless some particularly revolutionary type of ship construction were evolved, Nos. 1 and 5 would not lend themselves readily to the stowage of square loads.

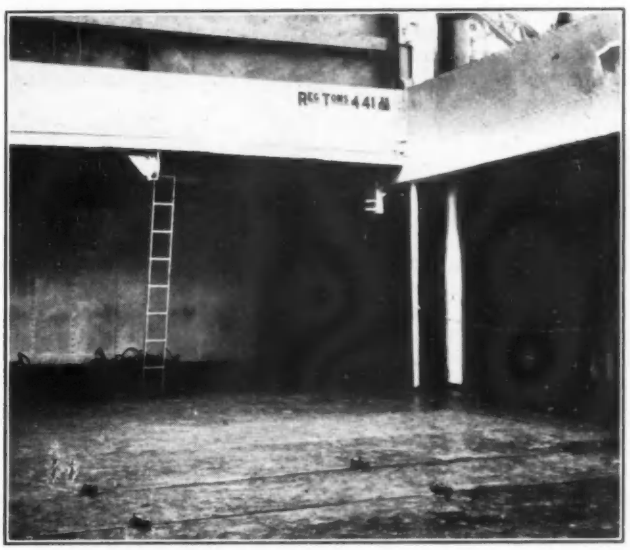
Stacking cargo by fork-lift truck raises, of course, the question of the height of the 'tween decks and if one is logical, one must come to the conclusion that, considering only the needs of mechanical handling, 'tween decks for this purpose should be about 16-ft. high, i.e. about the stacking height of a standard truck with its 12-ft. lift. If this deduction is a valid one, it follows that, in a deep sea vessel, holds for unit load traffic should have more than two decks of approximately this height.

The need for a level ceiling raises the question of the propeller shaft tunnels which so often complicate the stowing of cargo in the after holds of a general cargo vessel. This problem may be solved for mechanical handling by designing the ship with its engines aft, as in the bulk carriers. This type of construction should also make it easier for the holds amidships to be built "square."

In some quarters the opinion is held that unit load traffic will lead to the provision of side ports and even hold lifts. Ships with side ports do exist and handle palletised cargo (and also vehicles on wheels) excellently. At the moment, however, they are in the main confined to special trades where the loading and discharging berths specially cater for this working method, where the kind of cargo is always the same and where (as in the Great Lakes, for example) there are no appreciable changes in water level. In some instances the ship has been fitted with a type of gantry crane which, when required for use, is projected outside the ship through the side port. Where this is the main method of loading, lifts serving the various decks may be installed. It is difficult to see exactly what will occur in connection with side ports in the design of the ships of the future. This method of getting cargo into and out of a ship, however, involves, at most stages of the work, operating up and down ramps—not ideal conditions for fork-lift truck work. Present indications, therefore, are that loading and unloading through deck hatchways are likely to be the primary method for at least a decade or two.

In this article, attempt has been made to see the future picture a little more clearly. It may be said in some quarters that many of the points made have already been covered in the construction of new short sea and coastal vessels. This is so, but the problem of deep-sea vessels is a different one. Nowadays, it is nearly always essential that they sail fully laden. With the smaller vessels, however, voyage time is much shorter; thus, although it is desirable to have as large a freight as possible, this is not quite as important economically as it is with deep-sea vessels. There are many instances, therefore, of short sea and coastal vessels making voyage after voyage not fully freighted; in some cases, indeed, palletised goods are regularly stowed only one load high, leaving the rest of the cubic space of the deck unoccupied. This would not be an economic arrangement for a deep-sea vessel; thus, the need for quick work and a full utilisation of all available freight space.

A summary of the foregoing does not reveal any startling proposals. The first point made is that there is obviously a move away from the method of handling and transporting goods as separate packages. The trailer-ship is evidence that this tendency is affecting sea transport, so are the vessels on the Great Lakes, constructed for large consignments of homogeneous goods in unit load form.



MacGregor flush steel 'tween-deck hatch-covers which can be opened quickly by a pull on a single wire. By dispensing with hatch coamings above deck level, the whole of the deck is made suitable for the employment of mechanical and other wheeled appliances.

In general industry it seems unlikely that the practice of handling consignments in "loose" form will continue to be popular when there are so many advantages to be gained by adopting the unit load method. If this be true, unit load traffic will ultimately increase at deep sea berths and general cargo vessels of one design or another will have to carry it.

Examination of how ship-design might alter for this purpose in the next quarter or half a century, produces the following suggestions: (1) derricks or deck-cranes should be of at least 5 tons capacity; (2) there should be flush decks in all holds; (3) hatch covers should be strong enough to bear the weight of a loaded 3-ton fork-lift truck; (4) there should be no cleats, trimming hatches, stanchions or other obstructions to the operation of mechanical appliances; and (5) hold ceilings should be level and horizontal. This may imply that the ship should be constructed with its engines aft of all holds, a tendency which already exists.

In holds designed particularly for palletised and other unit load cargo, there are operating arguments for (6) more than two decks, each something like 16-ft. high and (7) vertical sides—hold construction, in fact, aimed at making each deck as much like a box as possible. No doubt there is an important connection between deck design and ship strength; no doubt, too, modern speeds require the flare of the bow to be long—long enough indeed, to affect the design of No. 2 hold. It is appreciated that shipping companies and ship designers will have many other ideas than those expressed, especially since it may not be many years before nuclear energy is brought to a practical state of peacetime usefulness, not only for industry but for the propulsion of ships. The ideas mentioned, however, are some which arise from the practical considerations of loading and discharging.

Modern Dry Docks: Design, Construction and Equipment

1. General Survey

By E. L. CHAMPNESS, C.B.E., M.Sc., M.I.N.A.

The Owners Point of View.

THE subject of the undoubted and growing shortage of large dry docks in the United Kingdom has been amply ventilated in the last few years[1] and the prime cause of it is the rapidly expanding nature of the Oil Industry and the realisation of the economic advantages of transporting oil and similar bulk cargoes in large units.

Whereas relatively only a few years ago the ocean going tanker was of the 10,000 ton deadweight class of vessel with coastwise distribution from main storage tanks to local depots by small tankers, the ocean going tanker has steadily increased to various classes 12/13,000 tons, 16/17,000, 24,000, 32,000 tons sizes, of which there are large numbers in each class, and it proceeds apace to 45,000, 60,000, 85,000 and now the 100,000 ton deadweight Onassis and the 106,500 ton Niarchos Tankers. The former ocean going 12,000 tonner is now the coastwise distributor and, in turn, its size also tends to creep up as the larger ocean going tankers become available for use on the main supply routes.

Similar economic considerations also apply to the ever growing Ore trade and the Ore-cum-Oil type of carrier, and could also apply to Grain carriers, so that in course of time, in view of the predictions of growth in the Oil Industry, the necessity for more large dry docks to service these and similar large bulk cargo carriers will continue to present a problem. There is also a probable shortage of smaller classes of dry dock due to the beam growth of cargo vessels, but this is not so serious a problem.

In any case, though the focus of attention is on the large dry docks, the same principles and considerations govern the design and construction of new docks of all sizes. Progressive port authorities and private owners of dry docks (who are generally shipbuilders or ship repairers) are therefore actively considering, and some proceeding with, an extension of facilities to meet the situation.

It is the Owner who calls the tune when constructing a dry dock and his consulting and civil engineers who carry out the project, assisted in the equipment by mechanical and electrical engineers who provide the most up to date equipment to meet his requirements.

In embarking on a project of this magnitude to-day, involving a very high capital outlay, it is not without interest to review the background and the considerations which weigh with the Dry Dock Owner in his initial planning stage.

His first problem before considering details, is to choose the dimensions of the dock so that to the best of his judgment of future trends, the dry dock will last 50 to 70 years ahead in effective use and will not become obsolete or only partly used due to changing dimensions and proportions of length, beam and draught of ships. This is an irrevocable decision of great importance for although a dry dock can be lengthened where space permits, it is not a practical proposition to alter subsequently the other dimensions.

The factor of altered proportions of ships over the last 50 years is the prime cause of obsolescence, since the physical deterioration of the structure of a dry dock is not a problem—indeed dry docks, many of which are several hundred years old, are still in use for such vessels as they can accommodate and their ancillary equipment has been brought up-to-date.

The choice of dimensions involves a review of existing and projected ships mainly of three distinct groups—Naval, Passenger Liners, and Oil Tankers—at the time of the project, plus intelligent extension and projection of tendencies into the distant future. Prophecy, or perhaps more correctly, intelligent guesswork, is necessary, capable however of varying appraisal, and conditioned in individual cases by other considerations which are referred to later.

In dealing with dimensions it is as well to define those in use in docking questions. It is Length overall (L.O.A.), now given for ships in the new revised form of Lloyd's Register, and not Registered Length or Length between perpendiculars (L.B.P.) or length on waterline (L.O.W.L.) which must generally be considered in dry docking.

It is true that in most cases there will be a certain amount of overhang (small at the fore end due to raked stems and greater at the after end depending on the type of stern, cruiser or otherwise) above the level of the top of the gate and copings which will allow ships of L.O.A. exceeding dock length to be accommodated. This is dealt with in individual tight cases by the actual plans of the ship and the dock.

Similarly, to those not fully versed in the technicalities of shipbuilding and shipping, some confusion often arises in talking of a ship of "so many" tons. There are, in fact, Deadweight tons, Gross Register tons, Net Register tons, Displacement tons—light and load, etc.

It is the habit of ship owners and builders to talk of Tankers in terms of Tons Deadweight (i.e. the amount in tons she can carry in cargo, fuel and stores at her summer freeboard marks) and of Passenger Liners in Gross Registered tons, which latter is in fact a measure of capacity and not of weight. Naval vessels are also complicated by the tonnage referred to being a Displacement tonnage with a defined amount of Fuel, Reserve Feed water, etc., on board as defined by the Washington Treaty and superceding the old "Navy List Displacement" formerly used as a measure of size.

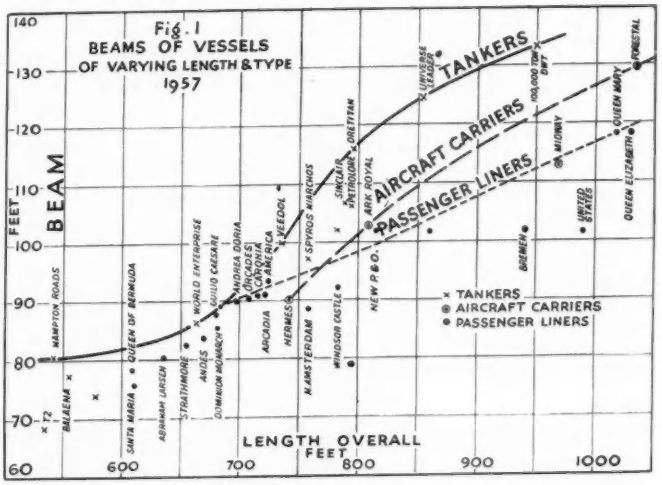


Fig. 1 gives an analysis of existing ships of the three main classes affecting dimensions and the three curves take account of the maximum beam for any particular length of ship. If this is kept up to date with any future vessels, it forms a useful basis of the background for choosing dry dock dimensions at any time.

Modern Dry Docks—continued

for, generally speaking, once these classes have been satisfied the general cargo vessel, intermediate cargo and passenger ships and other types which number an important proportion requiring service, will fit into the picture and be amply served, so that it is not necessary to analyse their dimensions separately.

It will be borne in mind, as dealt with later, that the width of dry dock will be 15 to 20-ft. wider than the beam of the ship for working space.

This deals with the present, and it will be seen that in dry docks of up to about 700-ft. in length there is no particular problem since the beams of the classes concerned fall practically within the same limits. Above this length, however, there is a necessity for much wider docks if Tankers and large Naval vessels, chiefly aircraft carriers, are to be catered for, due to the beam growth of these types. This increase in beam in commercial vessels is primarily due to the depth limit of ports, quays and channels—were it not for this, the most economic dimension to increase would be draught[2].

As to the future it is necessary to consider the three main classes of vessel separately.

Passenger Vessels of the Future.

The passenger liner problem generally remains static and is not the cause of demand since there are but few of the mammoth class and they maintain a shuttle service between ports adequately provided with dry docks to service them. It would be a shrewd guess to suggest that the beam growth of passenger vessels will not be so progressive in future years as it has been in the past. From the propulsion point of view the relatively slow tanker fleets (up to 18 knots) can afford beam without excessive power of propelling machinery but the crack liners (34 knots) cannot do so.

Part of the development in liners over the past 50 years has been due to the changes in the habits of the travelling public, the additional open air sports decks, covered-in sitting spaces on deck, swimming pools and lidos, etc., which combined with the vast number of life boats as a result of the "Titanic" disaster, have added to the top hamper of these vessels and led to increased beam for stability reasons.

It is difficult to see that much more can be added save to cater for those impatient ones who desire to fly on or off at terminal ports and save a few hours—and this type of passenger would probably fly all the way under modern conditions. At any rate, helicopter and other flying services can be operated from existing sports decks. Indeed with the availability and increasing use to-day of light alloy materials for superstructures and the possible tendencies for lower boat positions for stowage and embarkation, together with possible greater reliance on a proportion of inflatable boats, one might see a halt in the increasing of beam.

Nuclear power, as it becomes available as a prime mover, will not alter the proportions of ships since the hydrodynamics of propulsion remain the same irrespective of the type of propelling power.

Tankers and Other Bulk Carriers.

It is fortunate that the rapid developments of the past two or three years have already indicated that the future size of tankers will be up to 100,000 tons deadweight—over 900-ft. in length—and all that can be visualised in the future is an increase in the numbers of vessels within already known proportions.

In spite of the recent spectacular increase in size of tankers, there is a practical limit to the length of ships apart from the wisdom of having a very large capital sum tied up in one unit, and all that is involved in that in casualty or in damage repair, etc.

The limit is in manoeuvrability in terminal ports and estuaries and 1,000-ft. is suggested as a practical limit even for those few ports which can cope with vessels of largest size.

These 100,000 tonners are therefore not milestones in a steady and continuing rise in size but nearly the maximum and most will be of lesser dimensions.

Naval Vessels.

Touching but briefly on this type of vessel, it seems to have resolved itself at the moment into aircraft carriers and cruiser types with guided missile armament and the disappearance of the large capital ship. British policy seems to have called a halt to the very large carrier though United States developments still proceed with very large types such as the "Forrestal" and "Ranger." The largest British Aircraft Carrier, the "Ark Royal," is shown on the diagram.

Necessity for Width.

It will be seen from Fig. 1 that in the large classes of vessel to-day, if proportions of a dry dock cater for modern large tankers they will also include normal types of Naval vessels.

So much for prophecy on which the choice of the length and beam proportions will be decided. How rapidly such considerations may change and how differently they are gauged has been noticeable over the past five years, and in that time some of the most recent new large dry docks might be considered by some to be under the width which current analysis might deem prudent for the future. Here it is interesting to compare the dimensions chosen in several new docks of much the same size completed in 1955/56:—

	Length	Entrance Width	Depth of Water
1955 Smiths Dock, Tyne ...	709-ft.	95-ft.	27-ft. oversill H.W.O.S.T.
1956 Brigham & Cowan, Tyne	715-ft.	95-ft.	26-ft. oversill H.W.O.N.T.
1956 Burmeister & Wain, Refshaleöen ...	713½-ft.	99-ft. 6-in.	26-ft. overblocks H.W.O.S.T.
1956 Nordseewerke, Emden	715-ft.	98-ft. 6-in.	
1956/7 Swan Hunter, Tyne	715-ft.	105-ft.	29-ft. H.W.O.S.T.
Recommended width I.N.A.[1] 1953	715-ft.	104-ft.	

Other factors already known have a bearing on the necessity of greater widths of dry docks viz.:—

(a) The renewal of large areas of damaged plating (with its stiffeners) by prefabricated structure in large sections which can frequently be prepared in advance before the vessel's arrival and thus cut down the time in hand for repairs. Renewals particularly in all-welded ships will become questions of cutting out complete damaged parts (not necessarily to existing butts and seams) in sizes up to the full capacity of the dockside cranes. These large pieces particularly for replacement on the bottoms need space at the sides of the ship to be got down and into place before being welded up.

(b) Fitting of Stabiliser Fins or subsequent overhaul of the increasing number of these in Passenger Ships, require considerable space to withdraw or fit to the shafts.

(c) The growing practice in Passenger ships, Whale Factories and the like, of making machinery removals or renewals by cutting the necessary openings in the sides of the ship, rather than expensive disturbance of the accommodation, piping and wiring systems of several decks in the way of the machinery spaces.

These many points point the moral of selecting adequate breadth in a new dry dock and the necessity of avoiding under width proportions which has been only too frequent in the past.

Depth of Water over Blocks.

The only remaining main dimension is the depth of dock which is governed by the maximum abnormal high tide level and by the depth of water chosen above the after block level—and it is desirable that the cill level is a little below this.

In many cases this factor is dictated by the depth available at high water in the river or approach channel to the Dry Dock. Where there is a deep water approach up to the dock entrance there arises a problem of choice and compromise. Normally all ships dry dock in a light unladen condition at very much less than their loaded or service draught.

Docking of loaded ships is an occasional demand particularly where on departure loaded, some trivial grounding or a wire fouling the propellers may require examination or clearance which cannot be dealt with by divers or frogmen. Few Dock Owners care for such a job since it may involve excessive loading on the blocks and indeed it is customary to charge higher dues for such

Modern Dry Docks—continued

work. However, as such cases are few and far between, added depth to deal with them would not generally be contemplated.

The docking of vessels in a damaged condition either from marine risk or in wartime through enemy action has, in recent years, been frequent and the maximum available water is an asset in such cases; otherwise the only method of repair is by building a caisson round the damage to repair the vessel sufficiently for her to be put into dock. Vessels drawing over 40-ft. in the damaged condition were safely brought home and repaired in the last two wars.

Normally all ships in the light condition trim by the stern and in tankers and other vessels with machinery aft they are generally ballasted to reduce the trim by the stern to about 2 to 3-ft. to reduce the time after the touching down of the after end on the blocks before the whole keel length is supported all fore and aft.

Fig. 2 shows the actual docking draught aft of a number of tankers and passenger vessels of varying lengths and indicates that it is desirable where conditions allow to provide about 25-ft. for 450-ft. length and 40-ft. in large docks of 1,000-ft. length, allowing 2-ft. of water under the keel on first entry.

It should be noted that in cargo ships, including tankers, the difference between light docking draughts and load draughts is very considerable. In Passenger Ships, troopers, depot ships and Whale Factory ships, however, the docking draught is not so much less than the loaded draught and it is, therefore, in dry docks dealing with passenger vessels that depth of water over blocks becomes of greatest importance.

There are two types of Dry Dock Owners:—

(a) Public Dock Authorities in Ports and

(b) Shipbuilders and/or repairers.

The main considerations of dock construction are, of course, common to both but the latter may have considerably more equipment and some of his problems differ from those of port authorities, particularly those whose Dry Docks in large terminal ports cater in the main for a quick overhaul and turn-round to keep advertised schedules, whereas many ship repairers are concerned with major repairs, reconstruction work and work of a longer term type for the majority of their jobs.

Whether provision is made for all classes of vessel or not, will turn on several general factors.

Locality.

The facilities in Britain for active repairs of all types of vessel are based on the Clyde, Mersey, Tyne and other North East coast ports and are located adjacent to the shipyards where the largest vessels are built. They tend to be universal in their provisions.

London and Southampton, in their capacity of terminal ports for the largest liners, tend to restrict their requirements to this type of ship. Other ports, with limits in river or lock access, i.e. Manchester, situated at the end of a canal with known limits in the length and breadth of entrances of locks, or the Great Lakes ports after the completion of the St. Lawrence Seaway Project (with its locks 800-ft. x 80-ft. width and 30-ft. of water over sills) have limits which are set for the forseeable future.

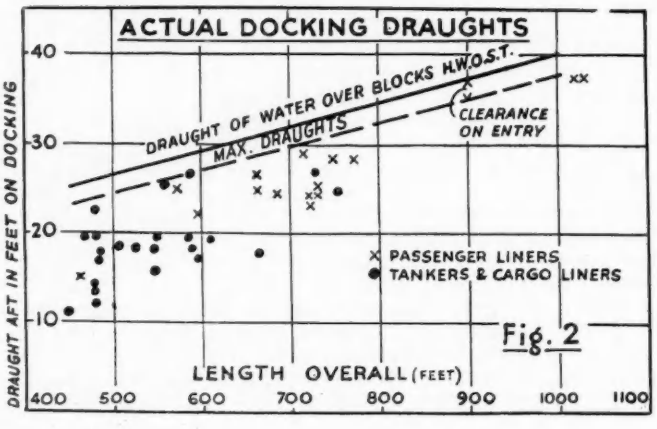


Fig. 2

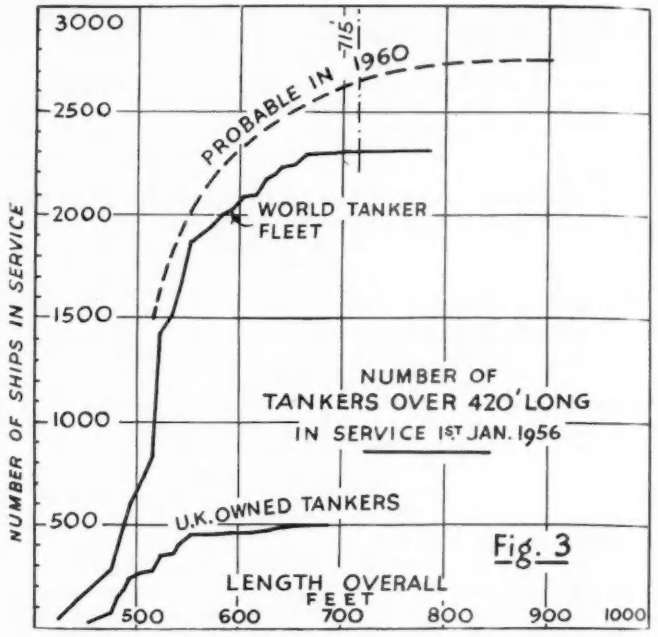


Fig. 3

The world's two largest canals will no doubt progressively increase their depth. It is intended to deepen the Suez, which has no locks, from 36-ft. to 40-ft. and later to 50-ft., with some possible widening in the years ahead. The economies of large bulk transport, however, may yet make it more economical to proceed via the Cape if canal dues increase to high levels and if the longer time can be made good in other ways. At the moment, the limit of the Suez is about a 38,000 ton tanker. The benefits of size transportation however apply equally to the short route through the Canal, and the Cape run is really not to be thought of except by reasons of limitations of size, or the unfortunate results of political moves in obstruction, or uneconomic raising of Canal dues.

The Panama Canal, with its series of locks and gates is limited to 1,000-ft. x 110-ft. entrances—i.e. a maximum beam of ship about 106-ft., is a different proposition.

Deep water ports elsewhere have no limits and can keep pace with increasing sizes of ships.

The Commercial Dry Dock Owner embarking on a new dry dock, assuming his land area and contour and his ancillary shops are not limited has a wide choice. The dimensions chosen may well be decided by the type and size of vessel he is used to in his business. Alternatively he may decide to cater for those classes and lengths of vessel which are most numerous but which, at the moment, are not the largest vessels afloat. He must also bear in mind the number of dry docks available for the size he chooses.

As far as United Kingdom Mercantile vessels are concerned the numbers afloat at end of June, 1956, were as follows:—

Length Overall	Number of Vessels
500-ft.—550-ft.	334
550-ft.—600-ft.	113
600-ft.—650-ft.	34
650-ft.—700-ft.	24
700-ft.—750-ft.	14
750-ft.—800-ft.	1
800-ft.—1000-ft.	None
1000-ft.—1050-ft.	2 (Queens)

World tendencies are no doubt similar and this accounts for the fact that many of the new dry docks recently built are limited to about 715-ft. in length. Indeed if the position of the world's tanker fleet at 1st January, 1956, is examined it will be found that in this fleet of about 2,700 vessels only four were over 710-ft. long and only 6 over 95-ft. beam. Of those on order at that date—building and deliverable over the next four years—some 520 vessels in all —only 20 were over 45,000 tons deadweight and could not be accommodated in dry docks of the above length, but at the beginning of 1957 there were about 220 tankers over 40,000 tons

Modern Dry Docks—continued

built or on order, of which about five were over 70,000 tons. The position is therefore changing rapidly. Only a proportion, however, of World Tonnage trades to European waters (Fig. 3).

The commercial owner may also have to decide whether he will let Naval considerations affect his plans. On this score he will doubtless weigh up:—

(a) Receding chances of a major war and the possible progress of disarmament.

(b) Lack of a clear indication as yet of Naval requirements in the light of new weapons of warfare.

Established firms with long and close connections with the Admiralty both in war and peace may naturally take such things in their stride, but others who normally concentrate almost exclusively on mercantile work are more likely to ignore Naval matters in their plans.

The problem of a private owner, or indeed a Public Docks Authority, catering for Naval requirements inevitably raises the vexed question of a Government subsidy towards cost. Admittedly a National and Defence service is being rendered on which, off-hand, the case for a subsidy is well founded, but there can be no doubt that private ship repairing interests are in general opposed to any subsidy.

Apart from a sturdy independence and the desire to stand free on a commercial basis, this opposition to subsidy is natural in that no private owner who has had the courage of free enterprise to embark with his own capital on new dry docks, could countenance State-aided competition, any more than he could cheerfully contemplate the Royal Dockyards undertaking merchant work and being able to work without profit or charge losses to Supplementary Estimates.

Subsidies are the thin edge of a Nationalisation wedge with its spurious attractions of non-profit working and cheapness which never materialise and always lack the spur of competitive efficiency. There might not, however, be opposition to a Government initial grant so long as it covered only the actual additional first cost of the special items generally required to cater for Naval purposes in emergencies. These are:—

1. Any agreed increase of normal dimensions to suit Naval types.
2. Magazine Flooding pipe lines.
3. Greater outreach of dockside cranes and for provision of shunt lines so as to clear sponsons, offset bridges and angled flying decks of Aircraft carriers when docking.
4. Provision for protecting of dock gates and pumping stations and services against air attack.
5. Special electrical supplies and capacity for war vessels in dock.

Such grants would not disturb the fair competitive position and would make it easier in times of emergency to make the private yards usable at short notice for Naval purposes.

Generally.

Whilst very large dry docks are necessary to service the growing numbers of mammoth tankers, present day costs of construction and equipment combined with the present charges for Dock Rent which are based on original pre-war capital costs in a pre-war economy, do not justify the enterprise considered as a unit in itself and for dry docking only, even if it were possible to fill the dock with a maximum size vessel continuously throughout the year. This is an ideal which for many reasons does not materialise in practice. The possession of a dock of a very large size by a ship repairer must, however, attract additional contracts involving repairing charges.

Both the ship repairer and Public Docks are forced to keep pace with current and future demands and bring their facilities in line if they are to survive. The large tankers—which are the dominating factor—require additional repairs as they age, involving renewals of structural work, surveys, etc., apart from the incident of weather and collision damage.

The headache of the owner of the large docks at the present time is to find them empty or used for moderate sized ships, with only occasional use for very large capacity vessels. This is only a likely hazard in the interim period until full usage comes with the increasing numbers of large vessels as the years go by. This problem led the author in 1953[1] to propound a double ended all-purpose dry dock on new sites or existing sites where the layout permitted.

It is of interest to note that since that date a large dry dock incorporating such features owned by the Italian Government has been opened at Naples[3] though the final piece has not yet been added. This dry dock when finally completed to plan will cater for the following variations in length:—

1105-ft.
or 176-ft. and 470-ft. and 406-ft.
or 176-ft. and 876-ft.
or 646-ft. and 406-ft.
with entrances 132-ft. 3-in. wide and 42-ft. 7-in. of water over cill.

It is understood that a similar project for a double ended dock of large size is under consideration at Stavangar, Norway, to be constructed between two harbour islands.

Arrangements such as these would remove the headache previously referred to in providing full revenue earning docks for almost any conditions of use or work offering.

Although the provision of an intermediate gate in long dry docks of the ordinary single ended design, theoretically allow two jobs on different length ships to be carried out, they are rarely used in practice when provided, chiefly because of the difficulties of timing the relative duration of the inner and outer jobs. To have a finished job trapped in the inner portion unable to be got out due to the ship in the other portion not being in a condition to float, is not generally acceptable. This situation may frequently occur as the duration in dock is not always known definitely in repair work until the vessel has been opened out for survey.

The double ended design gives therefore greater flexibility and overcomes this objection. The floor is level fore and aft, of course, in such designs and the intermediate floating caisson dividing the portions can fit in alternative grooves capable of pressure on either side.

By the exercise of thought on the foregoing lines the owner will have settled the vital questions of his new venture to suit his purpose. These decisions have to stand the test of time and will differ due to personal experience, the nature of present and future trade as he interprets it, the extent to which he places relative importance of the various items and not least on the length of his purse.

Though these are the main decisions, this is not the only matter an owner has to consider in his new dry dock. He is also vitally concerned in the lay-out vis-à-vis his various shops and facilities serving ships in dock, to reduce handling distances and double handling; in the capacity of type of cranes and in fact in all the details which he knows from his experience can make or mar a good dry dock from the working point of view.

Time of turn-round or repair has become increasingly important in these days of high costs and large expensive units so that anything in design or lay-out which can minimise time is important—little of this is possible in physical matters compared with labour questions, but undoubtedly the repairer who can give speedier service than his competitors has a wide open road to his dock gates.

On all these matters he will have decided views and will express them to his consultants, contractors and suppliers.

The Institution of Civil Engineers published in 1952 a Memorandum on the Construction and Equipment of Dry Docks[4]. Condensed into a brief 50 pages, this valuable little book gives short notes on the various items of dry dock construction and embodies the work of a panel of experts. Although it is not illustrated, it contains a vast amount of information summarising the results of considerable thought.

It also pays the owner to study the details of recent new large dry docks, which are available in various transactions of professional societies[5].

The time of an expensive venture such as the construction of a new dry dock—an event which occurs perhaps once in 50 years—

Modern Dry Docks—continued

is the time to review almost every operation in its usage with a fresh mind and critical eye to ensure that advantage is taken of any progress in equipment or development in materials which will reduce time or labour and increase efficiency. It is no time to repeat slavishly what has always been done in the past—and it is a long past as far as dry docking is concerned—and a conservative attitude has perhaps grown as a natural result.

Some of the points warranting attention on these lines are:—

Control when entering and leaving dock.

Minimum cleaning.

Use of pump discharges or compressed air to clear silt from entrances and reduce dredging costs.

Reduction in timber for blocks, staging, etc., and arrangements similarly to keep down heavy replacements of consumable items such as temporary light cables, all of which, at present prices, are a heavy drain on gross revenue.

Entrance Width.

The practice of making the width of dock entrances less (and considerably less, in some cases up to 20-ft.) than the width of the dry dock itself, is all too common in the majority of existing dry docks. Offhand it might seem right since there must be room to perform work round the docked ship, much more than is needed to pass through the entrance. But the practice is an unnecessary limit to getting the last ounce out of the cost of the dock dimensions chosen.

Not always is the damage to be dealt with on the sides of the ship and there are many cases where the ship can just squeeze into the dock where working space is not necessary at the sides because the damage concerned is on the bottom or at the narrower ends of the ship or stern or stem damage where there is ample room to work. Of course, there is the relatively small extra cost of providing a wider dock gate but this is fully justified by rendering the full width of dry dock usable.

This has been done in the recently opened new dry dock of Burmeister & Wain at Refshaleöen where the 99-ft. 6-in entrance is the full width of the dry dock. It is a point well worthy of attention.

The question of natural light being shut out in close fits does not matter at all since most repairs involve the use of local temporary lighting which is always available.

Altars.

Whilst formerly it was the practice to form the dock sides in a series of steps, the gradual disappearance of altars has been noticeable in modern docks. In many dry docks to-day it is the practice to dispense with side shoring entirely, relying on two side lines of blocks in addition to the keel line.

In ship repairing, depending on the type of damage repair, some shoring is however still considered necessary and the usual compromise is an altar at top level for breast shoring above the waterline of H.W.O.S.T. and probably another a few feet below. Otherwise the walls are straight-sided, sometimes with a slight batter.

The altars are frequently cantilevered from the dock sides in modern designs. Fig. 4 illustrates this and other features which satisfy the requirements mentioned elsewhere in this article.

Staging.

Modern docks increasingly use the various types of tubular scaffolding and towers. These are notably handy, durable and of a flexible nature and if arrangements are made in the design to have sockets on the altars to anchor them back, it is a convenience and can save some long uprights.

Staging planks are a continuous and heavy annual expense in any ship repairing establishment, particularly at present timber prices. Apart from wear, there is a tendency to cut them (apart from the handiness of circular saws and the custom of "firewood" difficult to check).

It is surprising that developments of light alloy staging lengths with chequered surface and simple interlocking joints are not resorted to in conjunction with the tubular scaffolding. Although probably initially more costly they would not require the continuous renewals involved in timber replacement and would pay for themselves over a short period.

Dock Bottom.

The period during which the ship has touched the blocks aft until she bears down all fore and aft on the keel blocks or "sews" as it is termed, is a critical one from the stability point of view. For that reason to reduce this period to a minimum, the floors of dry docks in a fore and aft direction are made with a declivity of approximately 3-in. to 5-in. per 100-ft. length. This is not essential however and many dry docks have level bottoms lengthwise and the stability matter is taken care of by intermediate shoring, beginning aft and progressively working forward and also by bilge blocks, mechanically operated or otherwise.

It has been usual to have a slight fall transversely from a centre flat portion, a fall of about 6-in. in the half width, leading to a drainage and sludge channel at the sides. These channels involve considerable hand labour in clearing mud, etc. This transverse fall has been abandoned in several modern dry docks, in favour of a flat bottom, relying on transverse culverts at intervals leading

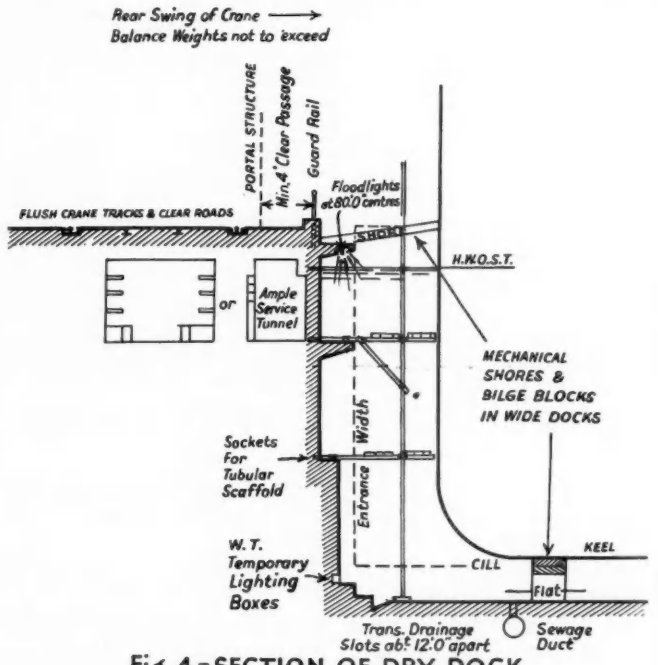


Fig. 4 - SECTION OF DRY DOCK

to side drainage channels. In large docks in the U.S.A. these transverse flush drainage slot channels are about 12-ft. apart and serve the useful purpose by T. headed bolts in the slots, to bolt down keel and bilge blocks, etc. They keep the dock bottom remarkably dry. The flat bottom avoids the difficulties of making up bilge or side blocks when docking two vessels abreast as frequently happens when no large vessels are offering for the use of the dock.

In dry docks dealing with Naval vessels or Liners with personnel living on board whilst in dry dock, arrangements must be made for the disposal of sanitary discharges which lead to culverts incorporated in the dock bottom.

Keel Blocks.

Owing to the frequent necessity in repair work of removing a certain number of these blocks after the vessel is docked so as to deal with bottom damage, the cast iron wedge type of block is generally preferred with, of course, wood cap blocks.

It might be anticipated that the lower portions of block make-up could be made of galvanised steel cradles suitably lightened instead of so much timber.

Modern Dry Docks—continued

Block Loads.

Whilst the maximum static load of a ship's weight occurs generally in way of the machinery spaces these spaces may be either amidships or aft. But apart from this, when the ship has touched down aft until finally settled on the blocks, a very intense loading of the after blocks occurs (e.g. the difference between weight of vessel and the lesser buoyancy due to the pumping out of the dock).

Also in ships with a considerable overhang both forward and aft where the keel cuts up from the level base line there is an added loading very considerably more than the average.

Apart from this, in large tankers, part of the routine overhaul consists of water testing the oil tanks with a head and in the very largest tankers with a centre compartment under water test, this alone can lead to loadings of up to 100 tons per ft. added to the weight per foot of the ship's structure. For these reasons the same loading on the dock bottom and blocks must be catered for all fore and aft whilst the blocks will be closer spaced and tied against tripping at the cut ups and first bearing point.

The loadings generally specified are:—

Largest dry docks over 600-ft. long—150 tons per foot run.

400-ft.—600-ft.—90 tons per foot run.

The loading per sq. ft. of block area is greater and depends on the spacing and width employed.

These figures take care of the weights of Naval vessels as well as of Merchant ships of all types.

Dock Pumps.

The Dry Dock Owner will decide and specify the time required to pump out the dock, which will settle the capacity of the main dock pumps.

Dewatering in modern docks varies from 2½ hours to 4½ hours with a moderate sized ship in dock.

Frequently, unless for a condition of emergency the full rate is not used once the vessel has fully grounded since the time of pumping out is often used to wet wash down the sides of the ship from mud and light marine growths from punts in the dry dock. Probably about three hours at full rating is a useful compromise in most cases.

Any arrangements by which the pump discharges can be led into the river and have scouring action to remove silt from the dock entrance or the apron of a Box Gate are advantageous in reducing the heavy cost of dredging in situations where silt is experienced.

Cranes.

The travelling cranes required by repairers in a dry dock are one or more for heavy loads up to 60 tons in large docks, plumbing the centre line of the dock for heavy machinery loads, propellers, shafting and the like and of such a height so as to clear the high superstructures of liner types which are 120-ft. above keel line in the largest vessels.

It is desirable that these cranes should avoid the type where the compensating balance weights at the rear of the crane increase the radius when the crane is at greatest outreach, as these weights tend to foul various items when revolved.

All dock cranes should have their own lighting fitted direct on to the load and also fitted with warning devices as to their approach and safe load indicators and cut off.

Crane tracks should if possible be kept to one standard so that mobility to other places where needed is ensured and the cranes are not confined to isolated lengths of track as independent units but can augment crane power at various places, e.g. repairing quays, etc.

Control on Entry and Leaving Dry Dock.

The methods commonly in use of towing the vessel into dock by means of one or two head wires (initially of long length) with ropes from bows each side being passed progressively to successive horn cleats by large gangs of men is, at best, an operation leaving much to be desired. In high wind on the beam there is the further hazard of scraping along the dockside or denting the shell plating —not exactly desirable when the vessel is undocking after completing repair and meeting a sailing date.

The extensive windage areas of the modern very large ships, particularly in the light draft docking condition, accentuate this problem and postponement of the operation due to weather may mean the loss of six or twelve hours at least. This is a loss which can be ill afforded, upsetting as it does the programmes both of dockowner and shipowner. Therefore, the risk is generally taken except in abnormal conditions.

Some attempt was made to deal with this point at Tilbury, by employing a specially designed lead-in girder against the bow of the ship to give lateral control, but the gear is expensive and adds a complication.

It should not be beyond the powers of our mechanical engineers to devise a simple but effective manner of control of this operation, say, by the use of travelling blocks each side on a rail running the length of the dockside, keeping a constant angle of tow and controlled by the head capstans. This tow would be paid out by the entrance capstans, as indicated roughly in Fig. 5. There is the alternative of using diesel towing locos on standard rail gauge each side, rather in the manner of those used in the Panama Canal locks.

It is becoming a practice to make the dock entrance capstans of greater power than those at the dock head, and there is something to be said for making these latter, winches with large coiling

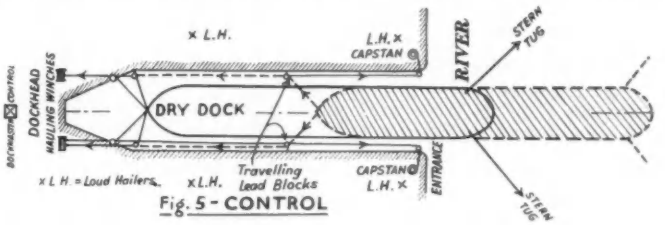


Fig. 5 - CONTROL

drums to take in the long lengths of head ropes without the necessity of providing separate reels for that purpose and undertaking two operations.

The considerable height above waterline to the forecastle head in large vessels leads to a steep angle for the bow ropes to dockside and an indirect pull where these are used for hauling in. This would be greatly improved by a bow eye in the stem, just above loadwaterline level, if this were incorporated in the design of the ship, a simple matter to arrange. This steep angle necessitates special attention to the design of bollards and horn cleats, to ensure that the ropes do not slip upwards and off.

Owing to the considerable height of ships' structure above waterline when drydocking, it is not possible to see over the vessel and the dockmaster has to rely on the shouted information of his officials and the pilot of the vessel to know whether she is coming up the dock centrally. The dockmaster is commonly positioned on one side near the entrance and megaphones seem to be scorned. Docking is essentially an operation controlled by one official only, otherwise chaos would result, and his instructions must be clearly heard and obeyed immediately and implicitly. It does not seem too imaginative to suggest that the ideal would be a central docking tower at the dock head with full visibility of both sides of the ship for the dockmaster, augmented by using electronics for information, if necessary, and giving his instructions loudly and clearly in all conditions of weather to his dockside men, men on board and tugmasters by means of loud hailers. No particularly expensive apparatus is necessary to attain such ordered control.

Lighting.

Owing to the urgency of the time factor, ship repair work goes on in the hours of darkness and dry docking being in general dependent on the time of the high tides, frequently takes place in the dark hours. For this reason adequate lighting is important in the dock area and in the dock itself.

With the lighting standards of necessity set well back from the dock edges in order to clear the travelling cranes, it is desirable to define the dock itself as is done in some modern docks with a series of lights preferably placed in water-tight cases just above the high water line as shown in Fig. 4. Each of these contains 3—1,000 W. lamps and is spaced about 80-ft. apart and arranged with group switches. They also provide adequate side lighting for repair work which is augmented by temporary lighting leads.

Modern Dry Docks — continued

There seems no reason why permanent leads should not be led down from the lighting mains in the service tunnel to water-tight boxes at intervals on the dock bottom level so as to reduce the trailing leads of temporary lighting cables which are so vulnerable to damage and general wear and tear and a matter of expensive upkeep.

Tidiness.

The casual visitor to some of the older dry docks would be struck by the general untidiness. A certain amount is momentarily inevitable, particularly in repair work where damaged portions are cut away and other arisings occur, currently used oil and paint drums, stores arriving, material arriving or removing, but most of it is due to lack of provision of stowage space for spare shores, staging planks, ladders, blocks and baulks, sullage and scrap bins, skips for oil sludge, rubbish, etc., trestles, scaffolding and uprights, long ladders, reels for docking ropes, etc.

If these be provided and discipline is exerted by the Dockmaster

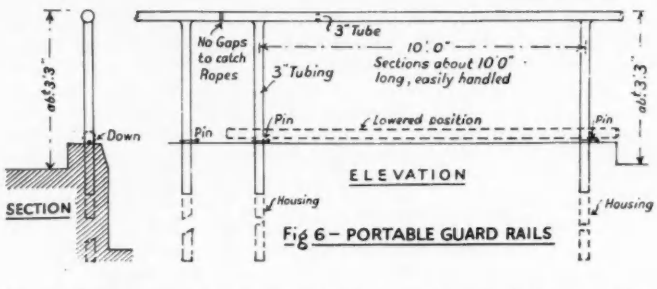


Fig 6 – PORTABLE GUARD RAILS

to see that it becomes routine to keep a tidy dockside, much of this would disappear and the roads and spaces round the dock would be kept clear (a matter of some importance in emergencies such as fire where instant access by fire engines is important).

The provision of these facilities in the design and layout is therefore important for general efficiency.

Guard Rails.

Guard rails round dry docks are not essential but are a Statutory recommendation and although not popular with many owing to the necessity of removing them for docking and undocking, or being in the way of gangways and other causes, they are an obvious precaution to be fitted. In many cases they are one of the untidy items referred to above, partly because they are not always replaced and the chains or wires are not set up properly but also because the types used are frequently bent and damaged by crane loads. They are often of the type fitting into a socket, or hinged at base with a single chain or wire run through the top, and rarely kept properly.

In a new dry dock some thought applied initially to this point could result in a design of more robust character, more easily handled and replaced. (See Fig 6).

Service Tunnel.

Modern dry docks now provided with service tunnels running fore and aft each side in the top of the walls have done much to clean up the dock side area by carrying all electric leads for light and power and the piping serving, F.W., S.W. and fire mains for tank testing, magazine flooding, compressed air, liquid oxygen, etc., besides being better for frost conditions.

Since these tunnels appear to save mass material in the walls it is surprising that they are not made considerably larger than present practice indicates. Adequate ventilation, besides ample space for maintenance and removals of pipes or possible later additions to services would be ensured by larger tunnels than used at present.

Accident Precautions Affecting Design.

Like every proprietor of an engineering works, the dry dock owner has his share of accidents which he takes care of by Yard Regulations augmenting Factory Act requirements by Safety Inspectors and other organisations, but he has also three potential major disasters which he must guard against, some of which affect design and equipment.

Fire[6].

Probably by far the worst disaster of the dock owner is the total loss of a passenger ship in dry dock and although the final fire fighting is in the hands of the Fire Services firms must have means of tackling instantaneously the numerous outbreaks and in most cases dealing effectively with them before the arrival of the Brigades.

The only matters involved in design are:—

1. Town's mains are frequently below pressure and with unlimited S. water available in the river the works fire mains round docks should be salt water capable of being drawn at any state of the tide and simple connections from a dock drainage pump if no separate S.W. pump is available can take care of this. Similarly at the dock entrance permanent stand pipes with non return valves at the foot keep these pipes fully primed so that Yard mobile fire engines can be instantaneously coupled up and made ready to function.

Piping carried in the service tunnels should be immune from frost and stand pipes should be kept short above ground for the same reason.

Every dock owner knows full well that every second counts in the initial stages of fire and can make the difference between a trivial incident and a major disaster—and prepares accordingly. Flush roads (kept clear) are also essential for rapid movement of Fire Brigade equipment both yard and Fire Service.

2. Fortunately ships toppling sideways off the blocks either during pumping out or when dry, are rare incidents. They do, however, still occur, and as recently as 1954 a large tanker did so. There is nothing in design which affects this potential trouble save a collapse of blocks or floors which is rare.

Accidental Flooding.

3. The accidental overflow of outside water over the dock gates on to a ship high and dry in dock can cause immense damage. It happened as recently as 1955 at Sheerness Dockyard with abnormal tides and winds building up the normal tides and flood water. In rivers a sudden winter thaw can also lead to temporary height of fresh water which if coinciding with the highest spring tides of the year and high winds can result in the same rise in level.

These are matters to be considered in the initial stages of design by consulting civil engineers who will investigate and settle heights of entrance, coping and quay levels with a margin sufficient to guard against both occurrences.

Both 2 and 3 have occurred in bombing incidents in the last war but beyond the necessity of adequate and extra line of bilge blocks and the armouring of dock gates in war time, there are no means of guarding against this contingency.

Final.

These then at some full length are the background thoughts of the Owner, who must rely on the expert knowledge of the Civil and Mechanical Engineer to carry out his project with the most up-to-date arrangements possible, combined with economy. They can only do so to best advantage with a full knowledge of the owners and users ideas and close liaison throughout the undertaking.

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Lead-In Jetty to New Graving Dock in Port of Dublin*

By M. F. ENNIS, B.E., B.Sc., A.M.I.C.E., A.M.I.C.E.I.

Introduction.

The floating caisson type construction for quay walls was originated in the Port of Dublin in 1921 by Mr. J. Mallagh, the then Engineer-in-Chief. There was no record in the Port at that time of this method having been previously used elsewhere in either Great Britain or Ireland. Mr. Mallagh's Paper to the Institution of Civil Engineers of Ireland in 1928, entitled "Description of the New Deepwater Quay at the Port of Dublin" describes in detail the design and construction of Alexandra Quay in 1921 using floating concrete boxes or caissons.

This basic design, with very few modifications, has been used for the construction of all deepwater quays in the Port since 1921. The first caissons built for Alexandra Quay were 40 feet long by 28 feet wide by 42 feet high with 1 foot 9 inches thick external walls and 9 inches thick diaphragm wall. Towards the end of the construction work on the quay the size was changed to 50 feet long by 30 feet wide by 42 feet high with walls of the same thickness. This is the size of the caissons still in use. The external wall thickness of 1 foot 9 inches is maintained in order to enable workmen lifting and setting shuttering to work on the walls, thus avoiding the need for scaffolding which would become necessary if the thickness was reduced.

The caissons in Alexandra Quay were founded in a trench dredged to between 36 and 37 feet below Low Water Ordinary Spring Tides and the caissons were founded lengthways along the trench with an interval of several feet between caissons. They were then filled with concrete and when the gaps between the caissons had been closed front and back with sheet piles these were also filled with concrete. A mass concrete retaining wall was then built on the top of the caissons, which were above Low Water, to finished quay level. This type of construction has proven over the years to have been very suitable to the site conditions prevailing in the Port and has also been notably economical. Some modifications to the caissons in recent years enabled gravel filling to be placed in the caissons instead of a lean concrete filling as previously used. This effected a further considerable economy in the cost.

During the post-war years two oil jetties were constructed in the Port and designs based on the use of caissons were adopted. The Lead-in Jetty is an instance of how it was possible to adapt the caissons to this type of structure. Where circumstances are suitable for the construction of the caissons, the Author feels that this type of jetty may have certain advantages over a piled type jetty as, being a more robust structure, it enables less elaborate and cheaper fendering to be used and in addition has a lower maintenance cost. It may also prove to be a practical form of construction where the ground conditions do not readily afford adequate load bearing capacity for piles, as in the present case.

The Lead-in-Jetty, which is 443 feet long by 36 feet wide, is situated in Alexandra Basin and is accessible by land from the North side of the Basin between the old and the new Graving Docks. The new dock is immediately to the East of the jetty (Fig. 1).

Planning and Layout

The jetty has to fulfil two main functions:

(a) To provide mooring facilities while "leading-in" vessels to the dock.

(b) To act as a fitting-out jetty for lighter repair work which does not require the vessels to be docked.

The tidal range of mean spring tides in the Port is 13 feet and it is standard practice to fix the deck levels of quays and jetties at 6 feet above H. W. O. S. T. As the site in Alexandra Basin was already dredged to 30 feet at L. W. O. S. T., the height of the jetty above dredged level was thus determined at 49 feet. It was decided that a length of 445 feet would enable adequate mooring facilities to be provided for "leading-in" and mooring ships of approximately 600 feet in length and of a gross tonnage of up to 20,000 tons, this being the maximum size vessel for which the graving dock is designed. It was decided that a length of 445 feet would enable adequate mooring facilities to be provided for "leading-in" ships of up to 600 feet in length. It was also thought that a longer jetty would unduly restrict the approach to the berths at the west end of Alexandra Basin. The width of the jetty was determined, partly by the space required for fitting-out operations and partly by the width available at the quay wall between the old and new graving docks. No provision was made for a permanent crane as the new dock has been equipped with a travelling crane with a capacity of 25 tons with which it is

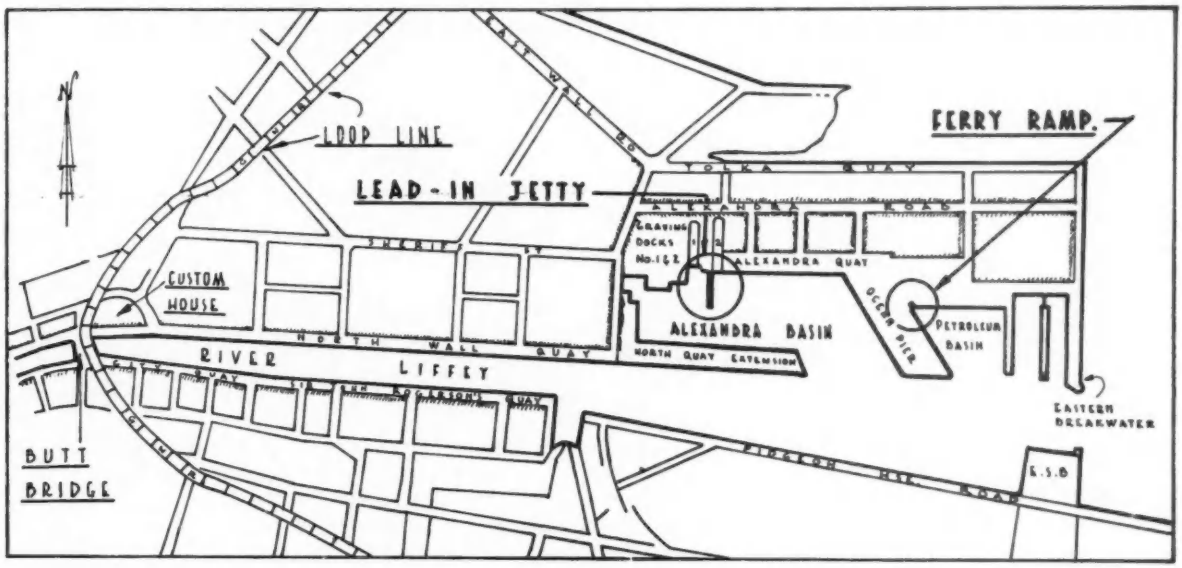


Fig. 1. Site plan.

*Paper read at a Meeting of the Institution of Civil Engineers of Ireland, March, 1957, and reproduced by kind permission.

New Lead-In Jetty—continued

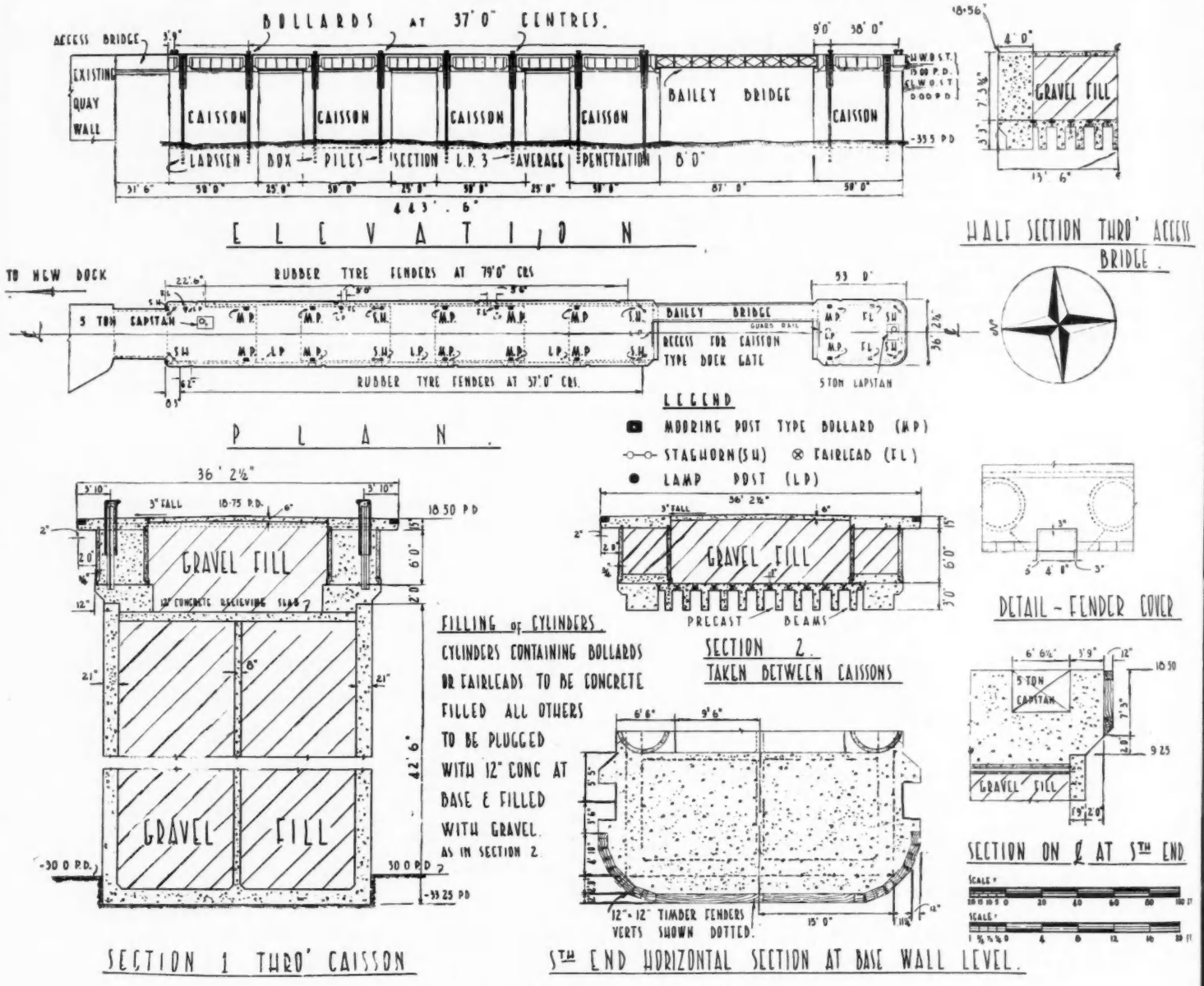

BOLLARDS AT 37' 0" CENTRES.
ACCESS BRIDGE
EXISTING QUAY WALL
CAISSON
BAILEY BRIDGE
LARSSEN BOX PILES SECTION L.P. 3 AVERAGE PENETRATION
GRAVEL FILL
ELEVATION
HALF SECTION THRO' ACCESS BRIDGE.
TO NEW DOCK
RUBBER TYRE FENDERS AT 79'0" CRS
5 TON CAPSTAN
RECESS FOR CAISSON TYPE DOCK GATE
RUBBER TYRE FENDERS AT 37'0" CRS.
PLAN.
LEGEND
MOORING POST TYPE BOLLARD (MP)
STAGHORN (SH) FAIRLEAD (FL)
LAMP POST (LP)
PRECAST BEAMS
DETAIL - FENDER COVER
FILLING OF CYLINDERS
CYLINDERS CONTAINING BOLLARDS OR FAIRLEADS TO BE CONCRETE FILLED ALL OTHERS TO BE PLUGGED WITH 12" CONC AT BASE & FILLED WITH GRAVEL AS IN SECTION 2.
SECTION 2. TAKEN BETWEEN CAISSONS
SECTION ON ℄ AT 5TH END
12"-12" TIMBER FENDERS VERTS SHOWN DOTTED.
SECTION 1 THRO' CAISSON
5TH END HORIZONTAL SECTION AT BASE WALL LEVEL.

Fig. 2. Plan and typical sections of lead-in jettty.

intended to do all the heavy lifts. It was thought that the ships' derricks and a mobile crane on the jetty would prove adequate to cope with any lighter lifts that might be necessary.

A suitable berth had to be provided in which to moor one of the dock gates for what might prove to be fairly long periods, while at the same time interfering as little as possible with the general operation of the jetty. The dock is provided with two gates of the floating caisson type. The second gate can be either of two intermediate stops in the dock, thus forming, when needed, an inner and an outer dock. When not in use the second gate must be berthed at the jetty. The gates are approximately 87 feet long by 24 feet wide by 34 feet high. Eventually it was decided to form a recess in the west side of the jetty, 90 feet long by 24 feet wide, near its southern end and thus provide a safe berth without causing undue interference to the smaller vessels which will use the berths on this side.

Design Considerations—(General)

A number of designs were considered and on the basis of the type of material occurring at foundation level in the Graving Dock and at the adjacent Alexandra Quay, a design based on the use of large cylinder type piles, in rows of two at 25 feet, centres, was adopted. The cylinders, as designed, were to be braced at the top by a reinforced concrete frame and deck slab and consisted of 6-foot and 5-foot diameter concrete cylinders 6 inches thick with three No. 3 section Larssen box piles driven inside them. Mild steel reinforcement and concrete filling was then to be placed inside the cylinders. Materials were ordered in accordance with the above design.

Subsequent piling tests indicated that this design was not particularly suited to the site conditions and it was then decided to change to a caisson type jetty. The caissons were of the standard reinforced concrete type which has been used in the Port for many years in the construction of the deepwater quays. The design finally adopted, consisted of caissons, founded 25 feet apart and filled with gravel with precast reinforced concrete beams spanning between them. The superstructure was to consist of gravel filling, retained on either side by a tied retaining wall and provided with a 6 inch thick concrete surface slab. A surcharge load of 4 cwts. per square foot was allowed on the deck.

New Lead-In Jetty—continued

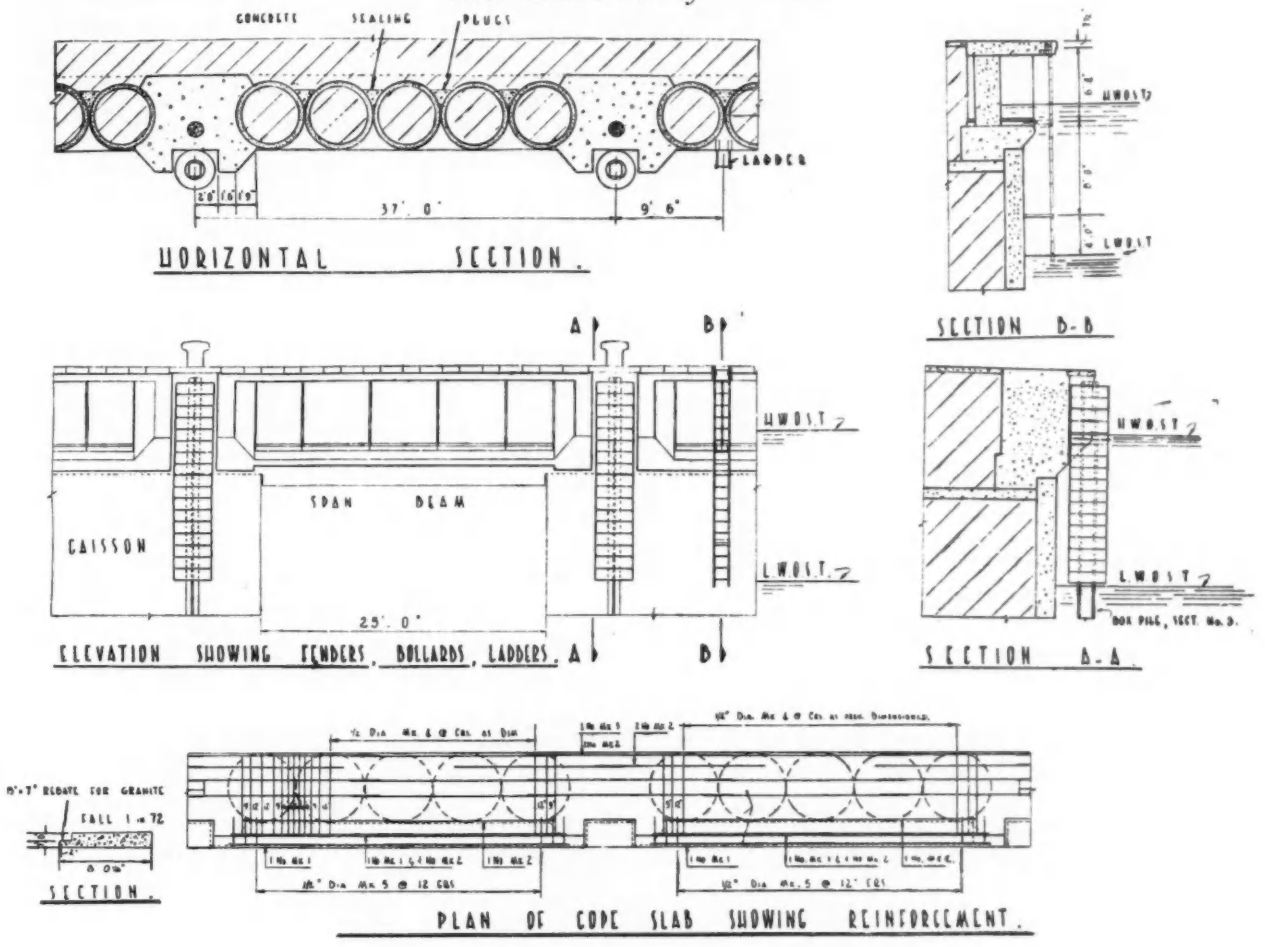


Fig. 3. Lead-in jetty—Miscellaneous details.

Scale in feet.

It was necessary to provide a 90 foot gap between the ultimate and penultimate caissons at the southern end of the jetty in which to berth the second gate. The problem of providing access for a mobile crane across this span was overcome at low cost by using second-hand Bailey-Bridging.

Caissons

The caissons, which are 50 feet in length by 30 feet in width by 42 feet 6 inches in height, have one foot nine inches thick external walls with three equally spaced transverse walls and one longitudinal wall along the centre. These internal walls are 8 inches thick and are provided with several "windows" each 8 feet in width by 2 feet in height, to allow the hydraulic gravel filling which was placed by the Board's suction dredger, to disperse freely. The internal walls were reinforced as ties to act as supports to the external walls which were designed as horizontal continuous beams. When built to their final height of 42 feet 6 inches the caissons had an 8 foot freeboard with a depth of 14 feet of ballast inside, which was composed partly of mass concrete and partly of water. Thus a maximum of 20 feet external head of water had to be allowed for. Since this was a temporary loading condition, occurring only during construction, a value of 25,000 lbs. per square inch was used when designing the reinforcement.

On founding, the caissons were hydraulically filled with gravel and were designed to resist both, the internal pressure due to the filling when placed, and, the rather more severe pressure which occurred during and for a short period after the placing of the fill. A reinforced concrete relieving slab was provided over the top of the caissons in order to transfer the load from the deck surcharge of 4 cwt. per square foot, and from the gravel filling in the superstructure, directly to the caisson walls, and thus reduce the outward thrust on the external walls.

Superstructure

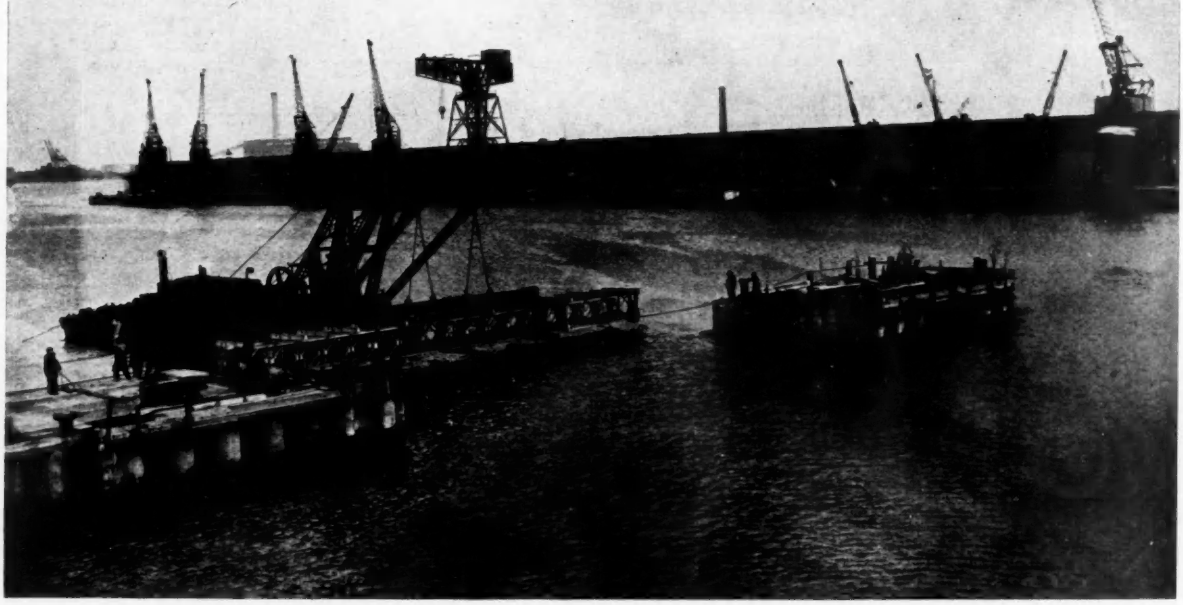
It was important that the weight of the precast concrete beams to span the 25 foot gap between caissons should not be greater than the capacity of the 6 ton crane on one of the Board's floating pontoons, with which it was planned to carry out most of the construction work. Accordingly, the tee section as shown in Fig. 2 was adopted and the weight of the beams fixed at 5.5 tons. A total of 33 of these typical inner span beams was required. In the case of the outer beams at either side of each span, it was necessary to use a rectangular section and to increase the weight to 30 tons, so as to ensure the stability of the superstructure wall which retained the gravel filling. These outer beams were also tied one to the other at either end of the span by a mild steel tie

New Lead-In Jetty—continued

encased in concrete. A floating shear-legs was used to place these 8 members.

The beams were bedded in mortar at either end and have a reasonable degree of freedom in the event of differential settlement occurring in the caissons. Any settlement that may occur is expected to be very small.

As the 6 and 5 foot diameter concrete cylinders ordered for the jetty, as originally designed, were available, it was felt that they could be used to advantage in the superstructure walls, details of which are shown in Figs. 2 and 3. A mass concrete base wall was provided as a foundation and was corbelled 12 inches beyond the line of the outer walls of caissons. Since a tolerance of 6 inches had to be allowed for in the founding of the caissons, this projection was necessary in view of the slight "out of alignment" which was likely to occur. On investigation, it was found that gravel filling in the cylinders would be adequate, if the wall was sufficiently tied at the top. In view of this the 15-inch coping slab running along the top of the cylinders was designed as a continuous horizontal beam with ties at 40 foot intervals. The spacing coincided with the bollard spacing required and the transverse 4 inches by 1 inch mild steel bollard straps, encased in concrete, provided the necessary ties. A shear connection between the cylinders and the base wall was effected by the provision of one inch diameter mild steel dowels, projecting 10 inches above the wall inside the cylinder and surrounded by a 12-inch layer on concrete.



Bailey Bridge being placed in position by floating shear-legs.

Fendering

Timber fendering has been used extensively in the Port on the deepwater quays. In recent years both the provision and maintenance of this type of fendering has proved to be very costly and the question of an alternative system has been under investigation for some time. The chief objection to the timber fenders was the high cost of maintenance, which has amounted at times to a complete replacement every fifteen years. The fenders used on the lead-in jetty represent an attempt to avoid this high maintenance cost and at the same time provide an efficient fender at reasonably low initial cost. A number of these fenders, details of which are shown on Fig. 3, were used experimentally at one of the oil jetties and as they were quite effective it was decided to use them on the lead-in jetty.

The fender consists of a Larssen No. 3 section box pile, driven 8 feet into the ground and extending to just below the soffit of the coping slab. A bracket on the pile at low water level acts as a support for the tyres. Numerous experiments were made with various types of packing in an endeavour to increase the energy absorption capacity of the tyres. None of these arrangements proved very successful. It was eventually discovered that a satisfactory degree of energy absorption could be obtained by omitting the packing material and clipping the rims tightly together. The clips consist of short lengths of $\frac{3}{4}$ inch mild steel rod driven through the tyre immediately behind the rims, bent tightly around them and the ends then lapped and welded together. Five of these clips were used on each tyre. Old bus tyres available at a very low cost were used. They have an overall diameter of 3 feet 9 inches, an internal diameter of 2 feet 2 inches, and fit neatly over the box piles.

As larger ships berthing at the jetty will be brought alongside by tugs and as the jetty, which is in a sheltered position in the still water of Alexandra Basin, is equipped with two electrically powered capstans, one at either end, it was decided, in view of the degree of control thus provided for vessels, not to design the fenders for impacts when berthing.

The worst condition of loading on the fenders was assumed to be the pressure that would occur from a wind load of 15 pounds per square foot, acting on a ship 600 feet in length with an average freeboard of 30 feet. It was decided, mainly as a result of experiments that this thrust of 120 tons, when distributed over four fenders, would cause a compression of approximately 10 to 12 inches in the tyres. Accordingly, the faces of the fenders were fixed 14 inches beyond the line of the edge of the cope slabs. A recess was formed in the overhanging slab to enable tyres to be replaced when necessary. This recess was provided with a removable cover and provision was made for bolting the cover in position in order to restrain the tyres from being lifted up along the box pile, in the event of a ship bearing against them on a rising tide. The concrete shoulders on either side of the fenders ensure lateral restraint.

It must be acknowledged that the idea for this type of fender was originally conceived by Mr. David Logan, Engineer and General Manager to the Larne Harbour Company, and that they are now known in the Port of Dublin as "Logans."

New Lead-In Jetty—continued

Bailey Bridge

The treatment of the 90 feet length of the jetty at the recess for the dock gate presented a number of problems. As the recess had to be 24 feet wide the width of the jetty would then be reduced to 12 feet over this length. On examination it became apparent that it would be rather costly to design this section as a structure capable of acting as part of the jetty proper. The problem here, arose due to the difficulty of providing sufficient lateral stiffness in a structure 12 feet wide, to enable it to resist the thrust transmitted through fenders from ships of up to 20,000 tons gross weight. A design of this type would have involved the use of elaborate and expensive buffer fenders. As piles would have to be driven to a considerable depth before a suitable set could be achieved, it was decided to span the 90 foot gap with Bailey Bridging capable of carrying a 5-ton mobile crane. The width of the bridge deck was fixed at 9 feet 6 inches and the eastern side was set back approximately 4 feet from the line of fenders and was therefore not required to take any lateral thrust from ships using the jetty. This seemed to be a suitable answer to the problem since some used Bailey Bridging was then available.

View of lead-in jetty nearing completion.

As the standard Bailey Bridge has an overall width of 18 feet, some modification of the standard arrangement was necessary. A single-double type Bailey was found to be adequate for the loading. Instead of the 18 foot standard transoms, 9 foot half transoms were used and the distance between the two double rows of panels reduced from 12 feet 4 inches to 3 feet 4 inches. This reduction prevented the deck of the bridge being laid on the transoms supported by the lower chords of the panels, as in the standard arrangement and made it necessary to place further half transoms across the top of the panels in order to form the deck at this level. The deck consists of 9-inch by 3-inch pitch pine.

To protect the bridge parts from the very severe corrosion to which they would be exposed they were metal sprayed with a zinc coating .007 inches thick. This coating was sealed with a chlorinated rubber solution.

Fittings and Services

The jetty is equipped with two 5-ton electrically operated capstans, one at either end, to assist in warping ships in and out of the dock. A number of fairleads was also provided at suitable points to prevent moorings from fouling lamp standards and other equipment. Bollards are of the standard cast-iron type which have been used in the Port for many years and have proved very satisfactory. Mild steel ladders are installed at 80 feet intervals.

A 4-inch freshwater main and a 9-inch saltwater firemain were provided, the pressure in the latter being obtained from pumps in the graving dock pumphouse.

The lighting standards are equipped with two separate sets of lights. One will give pilot lighting for normal night illumination and the other can be used in the event of repair work being carried out at night.

Construction

Work commenced on site at the beginning of 1956 and by the end of the year the jetty had been completed. The span from shore to the first caisson could not be constructed until the cofferdam at the entrance to the graving dock was removed. Because of this lack of a shore access it was necessary to carry out the site work by means of floating plant, all materials and equipment were conveyed to the site by barge.

The existing bed on the jetty site afforded an average depth of 29 feet at L. W. O. S. T. Dredging to a depth of 34 feet below L. W. O. S. T. was done by grabs operated from two steam cranes on one of the Board's construction pontoons. The spoil was loaded into a bottom dumping hopper barge. A 12-inch layer of gravel was placed by grab over the caisson beds and then levelled by means of a diving bell. The diving bell has a working chamber 20 feet square, access to this chamber being effected by a 40 foot high tower fitted at the top with an air lock. It was thus possible to enter and leave the working chamber without causing any interruption of the work in progress in depths of up to 40 feet. The diving bell is carried by a floating shear-legs of 90 tons capacity which also provides the necessary air by means of steam driven compressors. The average time taken to dredge and prepare a caisson bed was three weeks, two to three days of which were spent in levelling the bed in the diving bell.

The caissons were built two at a time and were constructed in lifts of 2 feet 3 inches, timber shuttering being used. By building the caissons two at a time it was possible to pour a lift each day, the lift on one being poured while the lift on the other was in the course of preparation for the following day. Construction of the caissons proceeded on a slipway in the Port Yard until a height of 10 feet was reached, at which stage they were launched. When

New Lead-In Jetty —continued

launched, they had a freeboard of approximately 2 feet. Construction then continued afloat, the concrete being supplied by a central batching plant and placed by means of one of the dockside electric portal cranes. On reaching the final height of 42 feet 6 inches the freeboard, which was cnotrolled by ballasting, was between 8 and 9 feet and the total weight was 1,400 tons. The time taken to construct a pair of caissons was 7 to 8 weeks.

Having been towed to the site at high water, each caisson was held in position by mooring it between the floating pontoon and the shear-legs which had already been anchored on either side of the prepared bed. Sinking was effected on the falling tide by opening two 6-inch flap valves in the outer walls. The gravel filling in the caissons was then placed hydraulically by the Board's suction dredger, the time taken being not more than four days per caisson.

Gravel filling being placed in caissons by suction dredger.

The concreting of the superstructure, the pile driving for the fenders, the placing of the precast beams, cylinders, bollards and other fittings, was carried out by means of the floating pontoon. This vessel is equipped with two steam cranes with capacities of 5 tons and 7 tons respectively. A concrete batching plant was erected between the two cranes from which the concrete was discharged into a bottom opening bucket and then placed by one of the cranes. The other crane conveyed the aggregate to the plant from a barge of 120 tons capacity moored alongside.

The concrete cylinders forming the walls present a somewhat novel feature and give an unusual, but not unpleasing, appearance to the jetty. They were very effective in ensuring rapid progress in the construction of the superstructure walls, the majority of them being placed during a two week period. They also eliminated a considerable amount of shuttering and in situ concreting in the tidal range which was a big advantage. The gravel filling between these walls was compacted by means of a vibrating plate. The degree of compaction achieved was such that it was possible to concrete the surface slab immediately after the services had been laid.

The fender box piles were driven by a No. 7 McKiernan-Terry hammer the steam being supplied from the construction pontoon. They were provided with a timber collar 8 feet from the toe as ground conditions were such that they would otherwise have settled under their own weight at their depth of penetration of 8 feet.

Acknowledgments

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Georgetown Harbour Approach Channel

Suggested Methods to Provide Increased Scour

By Capt. R. S. MORTIMER, Harbour Master.

The harbour of Georgetown is situated at the mouth of the Demerara River. The river is narrow in width, is tidal for a considerable distance inland and is navigable for sea-going vessels for 60 miles upriver to Mackenzie, where bauxite ore is loaded.

The river brings down a heavy quantity of earthy matter, from bank erosion action and the run-out from drainage canals, which is deposited in the estuary and forms an extensive soft mud flat outside the harbour. The mud-flat extends some 8 miles seaward before a depth of 2 fathoms is reached. The laden draught of a bauxite carrying vessel is governed by the limiting depth of water in the Georgetown sea approach channel for the particular time of loading.

It can be said, therefore, that a solution to the problems connected with increasing the draught of vessels using the port of Georgetown, or the bauxite loading terminal at Mackenzie, is entirely dependent on gaining and maintaining improved water depths in the sea approach to Georgetown itself.

Georgetown Harbour.

Georgetown has a wharf frontage of approximately two miles on the eastern bank of the river. Adjacent to the piled wharves there are a number of drainage canals, the sluices for which are operated on tidal height and the process of siltation is accelerated along the wharf frontage area, between low and high water marks, due to the effect of the drainage run-out from these canals. The quantity of soft mud deposited inside and along the face of the harbour wharves is a serious problem. As this soft mud area is not controlled and utilised to build up the piled wharf frontage area, there must be some further quantities of mud carried by the river discharge and deposited in the estuary and the sea approach channel to the port.

The same effect is found on the western bank of the river and this condition further assists the process of localised siltation, both between low and high water marks and in the sea-approach channel. It is believed that if the numerous drainage run-outs into the Demerara River, particularly in the vicinity of Georgetown harbour, were properly trained an improved river discharge in direction and strength would result. This, in turn, would undoubtedly achieve an additional measure of scour in both the harbour itself, and the sea approach channel to the harbour.

The depths in Georgetown harbour vary from 12 to 22 feet, and the average rise of tide is eight feet. The discharge of land and tidal water is well held within the east and west banks of the river mouth, and there is sufficient cross-sectional area in the harbour to allow the clear escape of the river discharge at an average velocity of 2 to 3 knots at all times. There is, therefore, negative excess of river discharge which could be trained and directed to provide increased scour in the estuary and the sea-approach channel unless the present cross-sectional area of the river mouth was reduced by costly artificial works in order to increase the current velocities and achieve greater scour. Further to this, it is considered that any increased current velocities so achieved would quickly dissipate when spilling over the mud flat outside the harbour, and perhaps do more harm than good by retarding the natural build up of those mud flats adjacent to the sea approach channel.

It is believed, then, that apart from controlling the drainage run-outs inside and near the river mouth, the harbour itself does not require developing, as the problem of improving the estuary and

Georgetown Harbour Approach Channel—continued

the sea approach channel depths can only be accomplished by concentrating on these regions in order to overcome the deteriorating water depths outside the harbour. The off-shore mud flat is being naturally formed by the slackening of the water discharge current on entering the sea coupled with the high amount of mud held in suspension by this discharge. It will continue to form, as natural influences are at work which steadily deteriorate the Demerara River estuary and the approach ground. In other words, it is clear that the mouth of the river is being moved towards the sea, but, with this natural movement, the river discharge must find an outlet channel.

It is the finding and maintaining of this outlet channel which is so important to Georgetown. The process of nature can be assisted to deepen and scour out the present sea approach channel by allowing the channel to receive the maximum volume of discharge water. (See the accompanying plan.) It is believed that the channel can be developed more effectively than it is at present without additional finance, by using the available dredging plant combined with a well defined channel.

The Sea Approach Channel.

The sea approach channel extends about 10 miles north-eastward from the mouth of the Demerara River, with depths varying between eight and nine feet for 6 miles, and then increasing to 22 feet at 10 miles. The average rise of tide is 8 feet.

The channel bed consists of a deep layer of very soft mud, and vessels of moderate and high power usually navigate the channel with some 15 inches over the limiting channel depth for the particular passage time. The additional 15 inches over the limiting channel depth can be termed a fluid mud allowance, and is locally known as 'crossing the Bar 15 inches over the predicted depth of water'.

The soft mud flats extend some 6 miles to seaward from the mouth of the Demerara River and, as previously stated, the flats are adjacent to the sea approach channel, which is about two cables in width. The present depth of water over these soft mud flats varies between 4 and 5 feet.

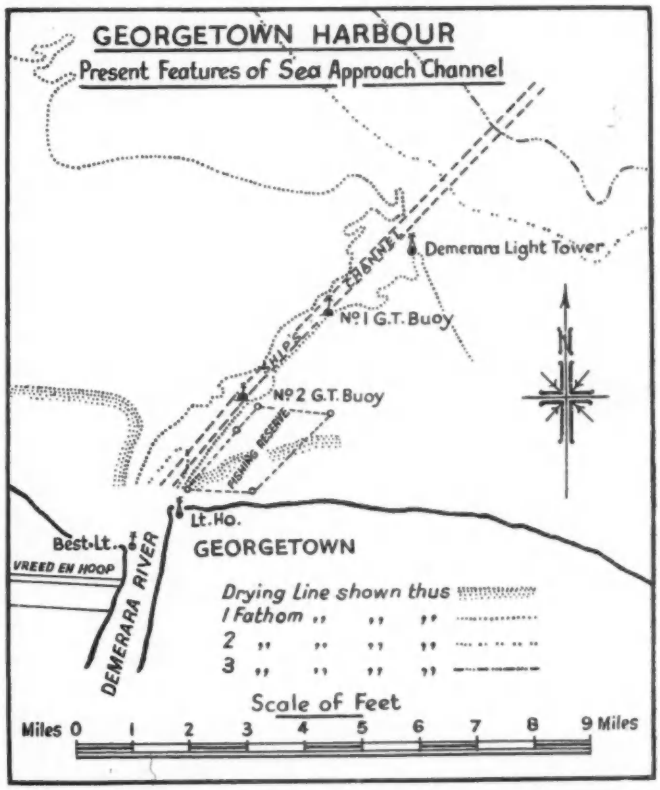
It is considered that the situation which has arisen, namely a channel of 8 to 9 feet in depth, flanked by mud flats of 4 to 5 feet in depth, is not difficult to analyse. The sea approach channel exists because it is wholly formed by vessels wandering a route, 2 cables in width, across the soft mud flat, drawing some 15 inches over the predicted water depths. There is no distinct channel formed by river discharge and any appreciable alteration which occurs in the channel depths from time to time is considered to result mainly from the volume of traffic entering the Demerara. The more vessels that enter or leave the river, the better are the water depths in the sea approach channel. The influence of wind and seasonal rainfall does exert an effect on the water depths, but such variations are slight and have little connection with the problem of permanently improving the channel water depths. The actual position is that a continuous soft mud flat is forming outside Georgetown, and as there is no natural channel the present sea approach channel wholly occurs because vessels traverse approximately the same route across the flat.

Hydraulic and Hydrographic Records.

It would be impossible to analyse the changes, from the data available, which have occurred and are still occurring in the estuary and the off-shore ground, as sufficient investigation has not been previously attempted. This is entirely due to financial considerations, and the question of whether recurring expenditure would be justified to gain useful information.

Continuous hydrographic survey work is undertaken in the Demerara River and its approaches but this work, although sufficient for chart making and the safe and timely movement of shipping, is not of a character to provide the accurate amount of varied detail required for river and channel development purposes. The extent of the work is only sufficient for the general requirements of navigation and wholly concerns chart making, port tidal information and the depths and nature of the bottom of the harbour and the approach channel. It could not provide sufficient recorded data for approach channel development works, such as dredging and channel training.

Definite hydrographic data is required, and must be obtained, before attempting absolutely to assess and substantiate what has happened in the near off-shore waters to Georgetown. The information regarding the tidal stream movement between eight and ten miles off the port and the limits of the South Equatorial Current is most incomplete. What is the effect of the fresh north-easterly winds between October and April, and is the water built up in the Demerara Estuary during this period? Do the north-easterly winds move the limits of the South-Equatorial Current nearer to the coast on occasions, and is the cross surge wave created when the winds are fresh or during a hurricane disturbance in the West Indies? Surely the tidal movement off the coast is affected by the equatorial current and the north-easterly winds, and what precise effect have all these factors on the mud held in suspension by the river discharge on entering the sea?



Tidal and ocean current limits and velocities in the approach waters to Georgetown must be studied and accurate information recorded. Certain water flows are undoubtedly in opposition, and when does this occur? Continuous specific gravities at different levels should be observed at the different tidal stages. It is essential that complete investigation is made, and maintained, of the estuary and the approach waters to provide a clear picture of the causes of the situation as it exists outside Georgetown harbour entrance.

Without proper records, it follows that the only reasonable construction of this natural development is that the coastlands are slowly moving towards deep water. As the process of river mouth deterioration and foreshore land reclamation successively takes place, the mouth of the Demerara will move seawards in a north-easterly direction some ten miles, and finally become established where the three fathom line is at present. In this connection, it is interesting to note that many centuries ago the region now occupied by Georgetown and its environs was salt swamp land, until the Dutch Settlers built sea defences and reclaimed the land. The river discharge did, therefore, spill over the swamp lands in former days in the same way as it is doing outside the river mouth today.

Georgetown Harbour Approach Channel—continued

Improvement of the Sea Approach Channel.

There has been a small and gradual reduction in the water depths of the sea approach channel to Georgetown, and the most important problem is to arrest these deteriorating channel depths without recourse to costly dredging and other improvement works which the present revenue cannot support. It is said that progress is the development of order, and it would seem that some order is an urgent necessity if the approach channel depths are to be improved. Due action is an urgent necessity in the interests of trade as the day may well come when present shipping is diverted elsewhere. To keep the mud moving is considered to be the practical and immediate answer to the channel problems, and, although the depth gains may only be modest, nevertheless every additional six inches of water gained does mean that the channel is being improved. This in turn also means about 300 tons of extra cargo for every vessel visiting the Demerara. The sea approach channel has a soft mud bed with a layer of fluid mud above; the channel is about 2 cables in width but is not considered to be efficiently marked. Two light buoys define the channel over a length of about 6 miles; the first light buoy is positioned 2 miles and the second 4 miles from the entrance to Georgetown harbour respectively. (See plan.) These two light buoys are on the south-east boundary of the channel, and there are no marks on the north-west boundary. This arrangement of channel marks can, in no respect, provide an efficient directional route for shipping and lateral displacement, which cannot be wholly attributed to mud drag conditions and the consequent effect on the steering performance of vessels, must result. The fact that all vessels must wander is quite definite, as it is impossible to maintain an exact position without a sufficiency of fixed marks on either side of the channel. It can be proved that distance cannot be accurately estimated on the visible sight of single objects at long range. Likewise it is impossible to navigate a vessel by distant leading marks placed on shore without a degree of error, depending on the distance the leading marks are from the observer. In the case of the sea approach, any leading marks placed on shore would be about five to six miles from a vessel navigating in the shallowest part of the channel, at which range a small error in sight steering would put the vessel out of its course. In hazy and wet weather, shore leading marks would be obscured, and have no reliable existence for channel navigating use. It must be accepted, therefore, that any channel assistance can only follow from a sufficiency of marks arranged in the channel itself, and that, if route accuracy is needed for vessels to canalise and deepen the channel, either buoys or fixed structures at close intervals are required on both the south-east and north-west channel boundary limits.

At this point it may be stated that, although the Demerara charts carry a general cautionary notice that the approach channel is subject to frequent change and buoys are moved as necessary, appreciable changes do not occur in the channel; at least not to the important extent of requiring the buoyage to be moved. This would seem to provide further proof that the channel is formed because it is the path traversed by vessels. It is considered that the chart cautionary notice formerly applied because the volume of shipping was less than it is today. Probably what did happen was that the channel tended to disappear and merge into the adjacent continuous shallow areas as there were insufficient ships to plough out the seaward approach. Returning to the question of defining and permanently establishing the sea approach channel, either by using buoys or fixed structures, it follows that the principal conditions to be observed by the authority responsible for the sea approach channel must be to provide efficient channel markings with the minimum expenditure on the upkeep and maintenance of these marks. Assessing these conditions, and bearing in mind the limited resources of the Colony, it is clear that the markings must be simple pile structures on both sides of the channel; the structures to be fitted with automatic battery operated lights, and suitable daymarks. The capital and recurring expenditure on buoyage is high, spare replacement units would be necessary, and annual servicing requirements would mean the employment of a vessel. The channel is to be a narrow approach path, 900 feet in width, and the piled structures are the obvious and suitable form of markers precisely to define the limits of the channel and to direct vessels along the same path.

The construction of the channel markers is worth mentioning. They will each consist of three piles driven on the batter. The top will be wire lashed and stapled, and the ground penetration will be limited to allow the structure to absorb movement if struck by a vessel. It is also for the absorption of this impact that the structure is wire lashed and not braced, as the piles can then ride if struck. It is intended that there will be six markers arranged at alternate distances of one mile along the channel. The structures will, therefore, be staggered along the entire length of the route and passing vessels will not be handicapped by having channel markers in their immediate passing vicinity. It is hoped to place substantial tide indicators on all the structures.

Loading Draughts.

When the defined channel is established it follows that if it is to be canalised and deepened partly by the ploughing out of vessels on a distinct route, the first consideration is to arrange safe increases in the draught of ships in stages. Safe increases will mean limited draught loading under reliable observations, and the careful keeping of draught channel crossing and performance records.

Dredging.

It must not be accepted that the deepening of the channel by the means described is the whole of the effort required, and, if the sea approach channel is to be deepened, some dredging or mud movement work must be carried out in conjunction with the increased draught loading of vessels. Georgetown has a very useful self-propelled grab hopper dredge of 250 tons capacity. The unit is normally used for wharf clearance work, but it is soon to be relieved by a small grab dredger to be used in the harbour and the sea approach channel as required. To dredge six miles of channel to an effective depth, and maintain this depth, would be quite beyond the capacity of the 250 ton grab dredger, as this is a clearance operation of considerable and costly magnitude. What the dredger can do is to tow a form of mud plough appliance during the flow of the ebb tide, and also clear hard mud patches by grab if they should be encountered. The application of the mud plough is rather interesting and local opinion is somewhat critical of the use of a plough as a means of carrying soft mud along the approach channel. Surely the answer to this criticism is that, as ships tend to plough out the channel, so would a towed plough produce the same or better effect? The very soft mud is agitated in both cases, and it is believed that the greatest clearance effect would be from the towed plough operated during the ebb tide, rather than from deep laden vessels traversing the channel at or about the time of high water. In any case, there is little harm in trying out a mud plough, as little additional expenditure is involved and the most important necessity is to endeavour to improve the sea approach channel by using whatever means are available.

Fishing Ground.

In 1953 a controlled fishing area (See plan) was established off the foreshore in the ground to the south-east of the approach channel. The local fishermen have taken full advantage of this concession and the ground is well worked. There is, however, a disguised aspect which concerns a possible quickened process of necessary siltation to build up the off-shore mud flat. The fishermen use the Chinese seine method, driving in stakes and hanging nets some 17 to 20 feet in length across these stakes. The nets are placed across the tidal flow, that is, in an approximately north-westerly and south-easterly direction, and there are long lanes of hanging nets over the region. It is yet too early to assess the effect of these nets and whether sediment is being deposited to any appreciable extent. It does seem obvious, however, that the fishing operations must assist the process of siltation and that, if the mud flat is encouraged to rise to the water surface level, more of the Demerara River discharge will usefully flow through the sea approach channel. Certainly any deposited sediment over the south-east mud flat adjacent to the channel could hardly be expected to move sideways into the channel itself, hence it is confidently thought that the fishing operations must ultimately exert a beneficial effect in directing a greater flow of the river discharge through the channel. This greater discharge flow should increase scouring action and generally assist the measures previously explained.

The Effects of Sea Water on Waterfront Structures

Part I. The Deterioration of Concrete

By LT. LLOYD E. STIFFLER, Jr., CEC, USN*

Deterioration of waterfront structures caused by sea water is one of the important problems facing the engineer responsible for the design and maintenance of such structures. A study of waterfront construction that has been in use in various locations for several years leads to the conclusion that the effects of sea water on structural materials have frequently been underestimated or at least not completely understood.

The designer of marine structures is often faced with monetary limitations with the result that desirable permanence must be sacrificed in the interest of low construction cost. A few years after the completion of such a structure the organization responsible for its maintenance finds that extensive and costly repairs are necessary.

It is granted that some deterioration will occur regardless of what precautions are taken. However, with proper planning during the initial design and care in construction, deterioration can be so minimized that the reduced cost of maintenance will more than offset the relatively minor increased cost of original construction.

General Factors of Design

The protection of waterfront structures begins on the drawing board. Though this statement has been repeated and amplified by many experts in the field of harbor engineering, it is too often overlooked or ignored with the result that repairs become necessary at a disconcertingly early date. In order to select the structural material to be used, the following design naviables should be considered:

1. The desired useful life of the structure.
2. The type of structure to be erected, with consideration of the class and density of traffic that will use it. For example, high-impact loading may preclude the use of prestressed concrete.
3. Design and exposure conditions, such as tidal currents, wave action, abrasion by sand, corrosion potential of the surrounding sea water to concrete and steel, marine borer infestation, physical and chemical characteristics of the underlying soils, etc.
4. Availability of materials locally.
5. A comparison study of the materials under consideration in regard to life expectancy, initial cost, and anticipated maintenance costs with the view of choosing that which is most economical.
6. Consideration of possible future maintenance problems inherent in the material, such as spalling of concrete.
7. Funds available for construction.

For good design, each of these factors should be considered and analysed, and by a process of engineering reasoning, the most suitable structural material should be selected.

One of the materials most universally used for marine structures is concrete, either plain or reinforced—particularly in structures where exposure conditions are severe and long life is desired under heavy use. Like all materials that come into contact with sea water, concrete is subject to deterioration and, in extreme cases, failure. At the present time there is still considerable disagreement among engineers and chemists regarding the relative importance of the causes of concrete deterioration, but fortunately the majority of the arguments are concerned with the more minor problems and almost complete agreement has been reached regarding the methods of prevention.

The quality of the concrete used as a structural material is a function of both design and construction and cannot be divorced from either component. To design a good high-strength concrete, and then to have a construction crew unfamiliar with concrete mix, pour, and place it carelessly without adequate supervision, is a waste of the designer's time. The result is mediocre or poor concrete that will not provide the required strength. Therefore to secure good concrete construction that will give adequate protection against deterioration, properly trained personnel must be employed to design, mix, and place the material with adequate supervision for all of these operations.

Of the many ways that concrete can deteriorate in sea water, the following are listed as being most important and representative:

1. Poor materials:

(a) Dirty or unstable aggregates, or poor mixing water.

A concrete is no better than its aggregates, regardless of how rich or well-placed is the mix. This statement is especially important when dealing with marine structures, because of the many additional attacking agents not normally found in dry-land buildings. Aggregate that is dirty or that is soluble in sea water creates a dangerous condition in marine structures because of its vulnerability to leaching out, thereby leaving the concrete a porous, weakened mass.

A good rule to follow in selecting mixing water is the one that says "If it is good enough for humans to drink, then it is good enough for concrete." Although most engineers are well aware of the seriousness of these problems, special care should be taken to insure compliance when dealing with waterfront structures.

(b) Damage to concrete by chemical action of sea water.

That cements are attacked by the sulfates in sea water is a fact. The American Society for Testing Materials has established maximum limits on the percentage of tricalcium aluminate for various types of cement and has recommended that those cements lowest in tricalcium aluminate be used in marine structures. Consequently, the type II cement with a maximum of 8 per cent. tricalcium aluminate is proposed for waterfront works.

When concrete is setting calcium hydroxide or free lime is formed which will react with the magnesium and sodium sulfates of sea water to form calcium sulfate, and magnesium and sodium hydroxides. These hydroxides are the whitish deposits on concrete walls that occur when the gravel used as an aggregate has been washed in sea water.

When subjected to seeping or flowing ground water or in a current of sea water the calcium sulfates will leach out, and as long as there is a supply of free lime to react with the sulfates of the water the deterioration will continue.

In all natural cold waters dissolved carbon dioxide is found which will react with the magnesia of the sulfate compounds allowing them to be carried away as soluble bicarbonates. If there are insufficient sulfates in the surrounding water to react with the free lime of hydration, the dissolved carbon dioxide in the water will react with it to form calcium carbonate, which is a stable compound. But if there is an excessive amount of dissolved carbon dioxide present it will react with the calcium carbonate to form calcium bicarbonate which is soluble in water and will leach out.

The amount of dissolved carbon dioxide that is available to react with the free lime is called "aggressive carbon dioxide." To cause deterioration of concrete it must be present in the water in amounts greater than 23 per cent. by weight.

(c) Chemical reaction between the aggregates and the cement.

Each brand and the various types of cements produced by any one manufacturer will vary in chemical content with the constituents used. Restrictions have been placed on the various types of cement with regard to limiting the percentages of chemical compounds included in the type, so that harmful or destructive ingredients are eliminated or restricted to minor amounts.

Unfortunately, in a large number of the natural rock pits used for production of concrete aggregates there are found percentages of chemical elements that will react with the alkali of the cements. This reaction usually causes an expansion and subsequent cracking of the concrete, permitting the sea water to have ingress to the reinforcing steel, and allowing a gradual build-up of salt deposits from the evaporating water due to alternate wetting and drying. This causes additionaf expansion and finally results in spalling.

This reaction between the cement and the aggregates will occur

*The author prepared this paper, which first appeared in the Civil Engineering Corps Bulletin, when he was on duty under instruction with the Naval Reserve Officers Training Corps Unit, Princeton University. He wishes to acknowledge the assistance of VADM W. M. Angas, CEC, USN (Ret.), Dean of Princeton Engineering School.

The Effects of Sea Water—*continued*

whether the concrete is in the air or immersed in water, but the process of deterioration is increased due to the reaction of sulfates with the cement and aggregates when in contact with a sulfate-rich water, such as sea water.

Ground waters in alkali-rich soils will be just as harmful, and in many cases the damage done will far exceed any that may be expected from contact with sea water. However, there must be enough alkali present to react with the total quantity of reactive aggregate, or the expansion either doesn't occur or is too small to be of concern. For example, tests showed that opaline aggregates will cause expansion with high alkali cements only when the opaline materials are present in relatively minor percentages, ranging from 10 to 15 per cent. Chemical expansion is apparent when the end product, a sodium silicate gel, is found in the concrete.

2. Poor workmanship:

(*a*) *Improper placing of reinforcing steel.*

When reinforcing steel is carelessly placed in concrete, unequal stress distribution may occur, permitting cracks to open in tension. If adequate protective cover is not provided water is allowed to reach the steel, resulting in corrosion and subsequent cracking and spalling due to expansion of the corrosion products.

(*b*) *Improper mixing and placing methods.*

In this category are grouped separation of the concrete during placing, use of too great a water content, too much vibration of the mix, insufficient or unequal vibration, inadequate mixing, improper bonding of succeeding pours or lifts, temperature of the surrounding air either too hot or too cold for proper hydration, use of mixing water that is chemically active with the ingredients of the concrete, and inadequate rodding or spading of the concrete to ensure that all of the out-of-the-way spaces are filled.

Poor workmanship results in a porous concrete, voids throughout the mix, less than adequate bond, honeycombing of the surface, and generally a soft material.

A survey made of marine structures on the California coast reached the conclusion that the majority of deterioration could be blamed at least in part on poor workmanship.

(*c*) *Rough handling of precast units.*

Concrete lends itself readily for use in precast forms for waterfront work, but in this form it can easily be damaged during handling, lifting, and placing. A poorly rigged precast pile, or one that is driven with a hammer that is too heavy, may show signs of chipping, or more severe damage that will eventually lead to a reduced load-carrying capacity and possible failure of the member.

3. Severe exposure.

(*a*) *Freezing and thawing.*

The freezing-thawing cycle creates maintenance problems in all types of concrete structures, but it is especially destructive in concrete immersed in sea water, particularly in the tidal range and splash zone. Tests performed by the Army Engineers over a period of years at Treat Island, Maine, show that an exceptionally well-made concrete can withstand for only a few years the cycles of freezing and thawing that normally occur.

Concrete, no matter how well made, is to some extent porous and can take up water, with the moisture penetrating the interstices of the concrete to depths proportional to the porosity. It is reasoned that the sea water, as it penetrates farther and farther becomes less saline, depositing its salts on the concrete, and as the salt content decreases the water is more easily frozen. Consequently it can be seen that at a given temperature slightly below freezing the internal water will freeze while the external supply will remain fluid. The formation of ice requires expansion room resulting in subsurface failure and subsequent spalling of the surface material.

(*b*) *Alternate wetting and drying and changes in temperature.*

Alternate wetting and drying of concrete in sea water will result in the formation of salt deposits on the surface of the mass. As cracks are formed, or if the concrete is porous, salt will enter the concrete and through either chemical reaction or expansive forces cause damage to the material.

(*c*) *Rusting of the reinforcing steel.*

A major cause of deterioration of concrete used in marine works can be the rusting of the reinforcing steel, particularly if the moisture reaching it is saline. The salt, acting as a catalyst, creates conditions favourable for the corroding of steel. Corrosion products require additional space, causing the expansion forces to break away the surface-protective concrete—thereby exposing the reinforcing steel, destroying first the bond of the steel to the concrete and, second, reducing the effective cross-sectional area of the steel.

(*d*) *Excessive stresses resulting from blows of storm waves, thrust from ships, or overloading of the structure.*

Storm waves, particularly the breaking type, exert pressures against marine structures that are damaging in themselves. (There is a difference between the wave that breaks just before or as it is hitting and the wave that is only reflected. The breaking wave results in a much higher force concentration.)

Even if these waves and their forces do not damage or destroy a structure directly, they can cause localized failures that appear in the form of hairline tension cracks. These local failures allow infiltration of water into the interior of the material.

Thrust from ships during docking manoeuvres or during storms and high winds, as well as overloading of the structure or individual member, will cause the same tension cracks to appear. Or the forces may even be great enough to cause localized failures in the form of spalling.

(*e*) *Abrasion by sand and gravel.*

Marine structures located where they are subject to water current velocities sufficient to carry sand and gravel in suspension are attacked by the action of the material in much the same way as sandpaper wears away wood. Sand and gravel (sometimes referred to as shingle) can wear away concrete sheet piling so that failure conditions are reached at the end of only one year.

(To be continued)

Belgian Coast Protection Works

Scale Models used to Investigate the Revetment of a Sandy Foreshore

By "ANCAIOS"

The widespread damage along the East English and Dutch Coasts which resulted from the storm surge of 31st January/1st February, 1953, is well known, but little information has so far been published on the considerable breaching and destruction of the Belgian sea coast revetments which also took place. Here the problem is essentially one of sand containment and conservation, and the following notes on the results of some model research upon various types of revetment and desirable foreshore slopes will, it is hoped, be of general interest. The abstracts given are from a paper by Professor J. Lamoen, entitled "Essais sur Modele Reduit Concernant des Revetements du Rivage Maritime dans le cas d'une Plage de Sable," published by the Hydraulics Research Laboratory, Antwerp.

General Data.

The following data were adopted as a basis for the initial experiments. The damaged sea wall at Heyst (a typical case) was investigated and a model based on the following constants was constructed:—

(a) Inclination of revetment slope: 1 in 2.
Top of vertical upstand at foot of slope: 3.50 m. O.D.
Top of revetment: 9.00 m. O.D.
The upstand height varies between the levels 3.50 m. and 1.00 m., the upstand comprising a vertical line of timber sheet piling with top waling.

(b) Foreshore slope: 2 per cent. for 200 m. seawards. The level of the foreshore in the model thus varied between 3.50 O.D. and −0.50 O.D.

(c) High Tide (Mean Ordinary Springs): 5.00 m. O.D.
Low Tide (Mean Ordinary Springs): 0.00 O.D.

Belgian Coast Protection Works—continued

(d) Wave amplitude (summit to trough): 2.00 m.
Wave length: 20.0 m.

After a series of experiments had been completed using these data, several alterations were made to the model (arrangement of the berms at the foot of the revetted slope, modifications to the gradient and the surface roughness of the wall, etc.) and the effect on the behaviour of the waves was studied in each case.

Description of Model.

The hydraulic research laboratory at Antwerp constructed a one-twentieth scale model, as shown in Fig. 1. Its least dimensions are about 36-ft. by 8-ft. The tidal flow is measured over a triangular notch and regulated by the vane of a tide simulator, the cam being cut to conform with the mean tidal curve at Flushing. The wave-producing apparatus is of the usual form and can produce waves of varying height and amplitude at a rate of from 30 to 150 waves per minute.

The tidal period for the model was regulated to be proportional to the mean tidal period of 12 hours 25 minutes divided by the square root of the scale of the model. In subsequent experiments the tidal period was further reduced to one hour (28 minutes flow and 32 minutes ebb) in order to shorten the time of the research by completing seven tidal cycles per working day. Further regulation was carried out in order to simulate the worst conditions of tide and wave obtaining at Heyst, with the result that a model wave amplitude of 17¼ cm. and the following wave lengths were adopted:—

State of tide.	Wave Length
High water	184
Half tide	179
Low water	172

After experiment, a light silver sand from Mol was chosen as being most suitable.

Study of Beach Erosion at Foot of Sea Wall.

It was found that the model foreshore reached an approximate state of equilibrium after ten tidal cycles had been completed, and a series of experiments was carried out to study the effect of various types of revetment, berm, gradient and surface roughness of the model sea wall, upon toe erosion of the foreshore material. A typical result is shown at Fig. 2, where a concrete berm has been added at the foot of the revetted slope.

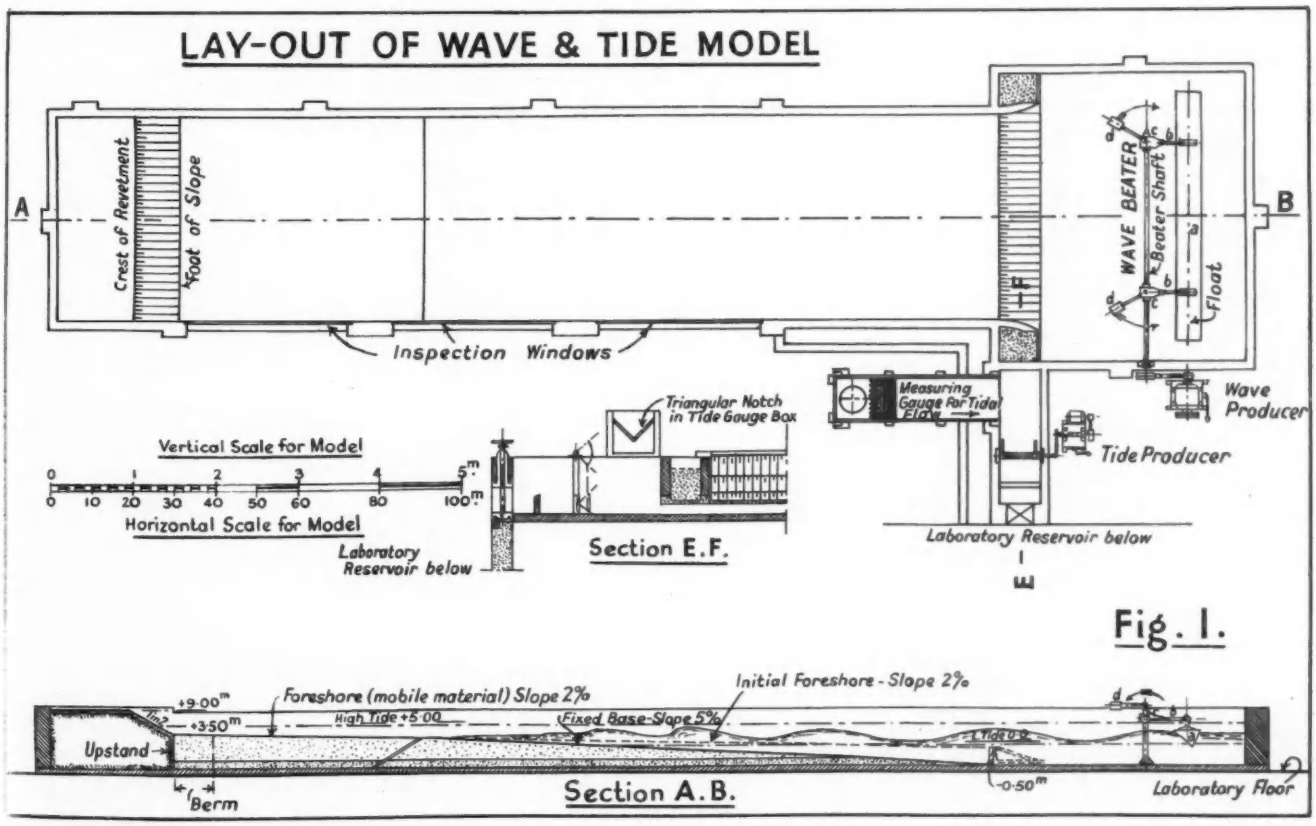
The following conclusions were drawn:—

(1) Toe erosion of the mobile foreshore material is at a maximum about the time of high water, whatever material is used for the experiments (white sand or lava ash).
(2) Toe erosion increases with increased slopes of the sea wall. A steeper slope than 1 in 3 is not recommended and a slope of 1 in 4 should be adopted where possible.
(3) In certain cases the effect of a berm was to accelerate the initial erosion. Where however foreshore accretion is taking place and there is little likelihood of the vertical cut-off of the berm becoming denuded, the stability of a sloping sea wall is increased if a berm is provided.
(4) It is worth while to provide wave-breaking protuberances on the revetted slope or to form such devices in a concreted wall (see Fig. 3).

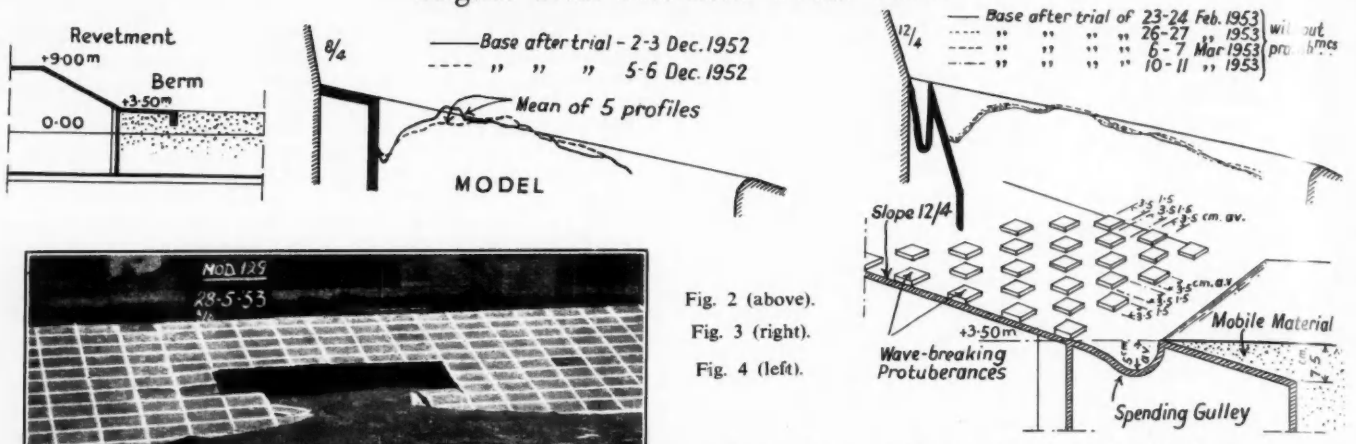
Effect of Tides and Waves on Inclined Shore Revetments.

Following the great storm of early 1953, a study was made of the damage which occurred on the Belgian coast. It was found that the stone-pitched revetment was breached in those places which were unprotected by large masses of sand, the latter having been denuded either before or during the storm. The breaches occurred more or less at the mid-height of the embankment, and it is thought that under the influence of sea water the sandy core of the embankment tended to flatten out so that the upper slopes of the revetment developed cavities and at a lower level the revetment became undermined. It was evident that this action was assisted by sea waves which overtopped the embankment and partially infiltered into the main mass of sand comprising the sea wall. The laboratory endeavoured to reproduce this destructive action in model form.

The arrangement of the model was as described before, but tidal and wave conditions were adjusted in accordance with the data given below under " Summary and General Conclusions." The



Belgian Coast Protection Works—continued



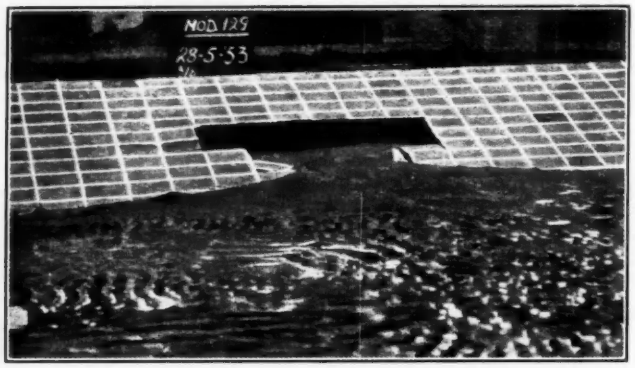


Fig. 2 (above).
Fig. 3 (right).
Fig. 4 (left).

slope was paved with small ceramic paving blocks, size 10 x 5 x 0.8 cm., and holes 0.3 cm. in diameter were drilled at the block junctions to simulate the seepage at interstices in the full-scale stone-covered revetments. A series of five studies were carried out with slopes varying between 1 in 2 and 1 in 4, and the following conclusions were reached:—

(1) Using a slope of 1 in 2, collapse of the paving took place after two or three tides in "rough" weather, and after six or seven tides in "calm sea" conditions. A typical collapse of the model revetment is shown at Fig. 4. With a slope of 1 in 4, gradual deterioration occurred in "rough" conditions after 12 or 13 tides.
(2) The embarkation slope and the promenade should be rendered as watertight as possible.
(3) The stability of the sea wall is increased if breaking waves do not overtop the promenade.
(4) The stability of a sea wall is greatly increased by a long spending face of gradual slope.
(5) Tidal action of itself causes slow deterioration of the wall and prepares the ground for rapid deterioration under storm conditions.

Influence of Revetment Slope on Wave Amplitude.

In this series of experiments, the mobile beach material was replaced by a cement slope, and the highest and lowest levels of the waves were measured under high tide conditions. The wave heights were measured at three points by an electrical contact method, and wave forms were studied by means of an oscillograph. A study was made of waves approaching and reflected from slopes which varied between 1 in 5½ and vertical. and the following conclusions were reached:—

(1) With very steep slopes there arises in the immediate vicinity of the sea wall, a very confused sea with clapotis effects, and measurements were necessarily inaccurate in these conditions.
(2) A revetment slope of 1 in 3 appears to be an optimum for design purposes.
(3) The surge height up both smooth and roughened slopes was measured and was found to increase as the slope increased up to 45°: a roughened slope had a definite effect in reducing the height of surge.

Summary and General Conclusions.

The model experiments discussed here were designed to obtain comparative answers to a definite problem having a known set of fixed conditions. Tidal currents were not reproduced and any littoral drift effects have been neglected. Nevertheless hydraulic scale models are of the greatest value where comparative answers are required, and it was possible to reach the following general conclusions as a result of the above-described programme of research:—

(a) The bank revetment and adjacent foreshore are least stable at about the period of high water.
(b) The reflection of waves is greater from a steep revetment and the risks of undermining of a sand or shingle foreshore and of destruction of the revetment increases with increased wave reflection.
(c) Very confused seas develop in the immediate vicinity of a steep sea wall slope, and the level difference between crest and trough is considerably greater than the maximum amplitude of the waves at sea.
(d) A revetted wall slope of not more than 1 in 3, and 1 in 4 where practicable, is recommended.
(e) There is a strong case for ensuring the maximum possible watertightness of both the slopes and the top of the embankment.
(f) Tidal action of itself caused gradual deterioration of the sea wall investigated.
(g) Initially, and where a portion of the vertical upstand cut-off piling became denuded of foreshore material, the effect of a berm at the foot of the revetted slope was to increase foreshore erosion.
(h) The steeper the revetted slope, the greater is the surge height of the sea waves. This surge should be limited so that the amount of water which reaches the promenade (9.0 m. O.D.) is kept to a minimum, thus reducing the infiltration of water into the sandy core of the sea wall.
(i) The slope of the embankment is the major factor in providing a stable revetment and foreshore. It is recommended that wave-breaking protuberances be formed on the face of the wall, as illustrated at Fig. 3. More complicated sea wall profiles (e.g. the addition of a berm with spending gulley as shown in Fig. 3), do not appear to provide worthwhile advantages.

Improvement Works at Helsingborg.

Work on the new South Harbour at Helsingborg, Sweden, which is being carried out in six stages, is reported to be progressing satisfactorily. It is expected that a large part of the harbour will be ready for use when the fourth stage of the operations is completed in October 1958. By that date the breakwater will be completed, work on the quays of the oil harbour will be finished and the oil storage area ready for use. In addition, the west side of the bulk cargo pier will be ready and dredging carried out in the harbour basins and entrance channel will provide a depth of 11 metres of water.

Recent work has been concentrated mainly on the casting of reinforced concrete caissons for the north breakwater. The caissons are 22 metres in length, 10 metres in breadth and 13 metres in height; each weighs 1,200 tons. The casting has been carried out in what will eventually be the basin between the bulk cargo pier and the oil storage area. When the basin is flooded and the dam at the entrance dredged away, the 23 caissons, standing where they have been cast, will be floated, towed to their respective positions and sunk on prepared foundations.

Selecting Wood Pallets

American View on Construction and Testing

By ERIC FORD

Despite the introduction of new materials, it will be a long time before wood ceases to be the most common material for the construction of pallets. Wooden pallets can, however, prove expensive if they are carelessly made or if unsuitable materials are employed in their construction. Moreover, there is also the safety factor to consider. For these reasons, the Bureau of Supplies and Accounts of the American Navy has sponsored some research into the construction and inspection of wood pallets, an account of which has now been made available in this country through the Technical Information and Documents Unit of the Department of Scientific and Industrial Research.

As the largest single user of wood pallets in the world, the American Armed Services naturally employ them in a wide variety of ways, in addition to the normal dock uses. Nevertheless, the principles of careful selection and testing laid down in the Report are of general application and will be of equal interest to those whose use of wood pallets is confined to dock working.

If hardwood is used in the construction of a pallet, the authors of the Report claim, it will combine long service with minimum cost, even under the most strenuous conditions. A properly constructed hardwood pallet, it is stated, will last for at least ten years, though this advantage is quickly lost if the material and workmanship are of inferior standard.

This will particularly apply to the pallet which is used in shipping operations where it will be required to handle a large number of different items, be subjected to many different types of mechanical handling equipment and, in some cases, be exposed to severe climatic conditions.

Where, for one reason or another, an all-hardwood pallet is unacceptable, it is recommended that softwood may be substituted for certain parts. Hardwood can then be used for the parts which have been found to be susceptible to damage, notably the outer end boards of the deck and the vertical support members.

If all-softwood pallets are to be employed it is recommended that the members should be of correspondingly greater thickness so as to be comparable to hardwood in strength and wearing qualities.

Among the different hardwoods used in the United States for pallet construction are included ash, beech, birch, elm, hickory, maple, oak and sycamore. These woods possess good nail-holding power and high resistance to wear while they also have a high cleavage value (i.e. resistance to the tendency to chip and split). This latter point is particularly important where pallets can be expected to be used in conjunction with fork-lift equipment.

Where softwood is used, either in company with hardwood or for the complete construction of a pallet, the selection of material is usually made from fir, hemlock, larch, pine or spruce.

Probably the most important single factor directly affecting the life and serviceability of a wooden pallet is the moisture content of the timber used in its construction. Pallets constructed from well-seasoned lumber have been proved to possess greater strength, resistance to decay and improved nail-holding while they also reveal minimum shrinkage properties.

It is therefore suggested in the Report that when purchasing new pallets the moisture content of the timber forming the chief components of the pallets should be carefully considered. This is a somewhat complicated technical matter since the moisture content of wood varies with the temperature, relative humidity and other local factors. However, two methods for determining the moisture content of wood are described in the Report, namely the oven-dry method and the electric moisture meter. The former method involves weighing a sample of the wood used in the construction of a pallet before and after it has been heated for about 24 hours in an oven at 100° C. Electric moisture meters, on the other hand, give an instantaneous reading.

This will perhaps appear to be too time-consuming a procedure when ordering pallets for dockside use and it will probably be thought sufficient to be assured, when purchasing new pallets, that they have been made from properly seasoned lumber. It is, however, worth taking some trouble over this for pallets made from "green" timber will tend to warp and shrink, thus causing nail heads to protrude with the consequent risk of damage to the goods handled or injury to the personnel handling the pallets.

It is also important to examine the quality (as apart from the moisture content) of the lumber from which the pallets have been made since even well-seasoned lumber of the right type will not give optimum service if the wood itself suffers from certain defects. One of the most obvious is the presence of knots in the wood which has obvious drawbacks. Cracks of various lengths and running in different directions are also to be avoided. Cross-grained wood (in which the fibres of the wood are not parallel to the length of the board) will not give the best service nor will wood which contains "pockets" or "streaks" of pitch (they weaken the components in which they are found and tend to exude resin in warm weather).

When examining pallets for these defects, some component parts are more important than others. The boards which form the surface areas of the top and bottom decks of the pallet, for instance, will, during their life, be subjected to severe impacts from the dropping of packages on to the pallet, the dropping and positioning of the empty pallet, the hoisting and manoeuvring of the loaded pallet on bar slings and the striking of the pallet boards by the forks of mechanical lifting equipment. It is therefore important that these boards should be free of any defects likely to lead to frequent repairs and consequent high maintenance costs.

Even more important are the "posts" and "stringers" (i.e. the pallet members to which the boards are nailed and which form the vertical supports of the pallet). These components largely determine the structural strength of the entire pallet since they must be able to withstand the sharp impacts caused by the careless entry of lift forks under the top deck and also be capable of providing the high nail holding qualities necessary to maintain a tight and strong pallet assembly throughout its entire useful life.

Post and stringers must be particularly closely watched for defects in the wood since the collapse of any one of these components in a pallet will render it useless. The repair of a damaged stringer is a lengthy business, which often costs more than the original pallet itself.

There are certain points in the construction of pallets which should be carefully examined, particularly the use of nails. American Armed Forces specifications require that grooved shank nails should be used in pallet construction, the spiral groove nail for hardwood and the annular ring type for softwood. Tests conducted at the American Forest Products Laboratory have shown that, under certain conditions, the grooved shank nail will provide more than six times the resistance to direct withdrawal from wood than the common shank nail.

Care must also be taken to observe the way in which the nails have been driven. They should, for example, be driven in below the surface of the board and all bent nails should be pulled out so that bags and other merchandise are not damaged when placed on the pallet deck. Accidents to personnel can also result from this fault.

Nails should not be driven into board in a straight line down the grain as this will cause splitting. "Nothing could be more simple than to employ a staggered pattern in driving nails," report the authors of the Report, "yet the failure to observe this one constructional detail is responsible for more damage and expensive repairs than any other single factor."

Despite the apparent simplicity of the ordinary wood pallet, it is, nevertheless, important that careful workmanship should go into its construction. This is particularly true of the work at the wood cutting stage because it is absolutely essential that all parts should be cut to the exact dimensions specified. Board thicknesses and the components forming the vertical supports between the pallet decks must be especially accurate to ensure efficiency and safety when pallet loads are tiered high.

To go into such detail when arranging for a fresh supply of wood pallets may appear to some to be unnecessary. But a supply of strong and reliable pallets makes a valuable contribution to the efficiency of port operations. There is surely much to be said therefore for ensuring at the time of purchase that these qualities are present.

International Association for Hydraulics Research

Notes on the Seventh Congress

By F. H. ALLEN, M.A., M.A.I., M.I.C.E.

The Seventh Congress of the International Association for Hydraulics Research was held in Lisbon on the 24th-31st July last, and was attended by some 180 delegates from 28 countries. The subjects for consideration were (a) scale effect, (b) cavitation and (c) hydraulics of intakes and outlets. Ten papers were presented on theme A, 8 on theme B and 25 on theme C. There was also a general section in which papers on diverse hydraulic subjects could be presented, and this accounted for 41 papers. The majority of the papers were concerned with matters which might not prove of particular interest to readers of "The Dock and Harbour Authority," and in the following paragraphs the writer has singled out those papers which would appear to be of most value in this respect and attempted to summarise their lines of argument and conclusions.

"Scale effects in two-dimensional beach studies" by Thorndike Saville, Jr.

This paper describes experiments on sand beaches, some of which were carried out in the Beach Erosion Board's tank for very large waves. The equilibrium profiles of a sand beach were established under four conditions of wave attack, with waves up to 5.5-ft. in height and also with 1/10 and 1/15 models thereof. In many cases the profiles obtained with the 1/10 and 1/15 models differed markedly from those recorded after attack by 5.5-ft. waves, and it was concluded that the deformation of the beach under wave attack is as much a function of the absolute size of the wave as it is of wave steepness. Earlier laboratory experiments have indicated that there is a critical value of wave steepness in deep water (0.02 to 0.025) which determines whether a beach will erode or build up under attack. The recent experiments reported in Mr. Saville's paper indicate that this critical value may not in fact apply to prototype conditions.

"Scale effect in hydraulic research" by D. V. Joglekar, C. V. Cole and S. V. Chitale.

This paper from Poona is a useful summary of various scale effects which may be found in models of hydraulic structures and in mobile-bed models of rivers, estuaries and harbours. Various expedients which may have to be adopted to minimise scale effects are described; for example, the effect of vertical exaggeration in a model of part of the Ganges was to steepen the model version of a stone-pitched bank to such an extent that it was nearly vertical. As a result, the secondary flow at the bank was incorrectly reproduced and unnaturally deep scour took place at the toe of the wall. It was found necessary to reduce the slope of the model wall to 45°, keeping the mid-point of the wall in the same position relative to the river's centre line as it was in nature, in order to obtain correct flow conditions at the boundary.

"Effet d'echelle dans les etudes d'erosion du sable par la houle et par le clapotis" by Jean Larras.

Herein are described tests carried out in a small wave tank at Chatou with various bed materials, such as acrylic resin, anthracite, sand, corundum and magnetite. The results—which compare well with those obtained by calculation—give threshold velocities for movement of the various materials and various depths of erosion.

"Effets d'echelle dans les etudes maritimes sur modeles reduits" by L. Greslou.

This valuable paper by M. Greslou (of Sogreah) is concerned with the effects of scale reduction on the various phenomena (wave decay, refraction, diffraction, reflection, sediment movements, etc.), to be reproduced in models of harbours, breakwaters, sea walls, beaches and waterways. The relative advantages of large scales, scale distortions and various bed materials are considered. The criteria governing the vertical exaggeration necessary in models of estuaries and channels with mobile beds are discussed; and for beach studies, where the required similitude of wave action makes large exaggeration undesirable, he recommends the use of bed materials of low specific gravity.

"The prevention of vortices and swirl at intakes" by D. F. Denny and G. A. J. Young.

Mr. Denny and Mr. Young (of the British Hydromechanics Research Association at Harlow) have been concerned with factors affecting the formation of air-entraining vortices and swirl at intakes. These have obvious applications to problems which may arise at the intakes to dock-impounding pumps and to some extent with the hydraulic filling and emptying systems of locks. The paper presents experimental results showing the effect of depth of water, velocity of water through the intake, shape of intake and strength of the rotational flow on air-entrainment and swirl. Comparison of models and prototypes over a limited range suggests that air-entraining vortices occur under similar submergence conditions only when prototype velocities are used.

"Emploi des traceurs radioactifis dans l'etude des mouvements de sediments sous l'effet de la houle et des courants" by G. Forest and P. Jaffry.

This paper describes successful experiments carried out by the Laboratoire National d'Hydraulique to follow the coastal movements of sand and shingle under the influence of waves and currents. In their experiments on sand movements, the radioactive isotope used was scandium 46, which had previously been used with success by the Hydraulics Research Station, Wallingford. The movements of shingle were followed by means of radioactive tantalum 182 inserted as wires or needles 5 mm. in length into holes drilled in each pebble, the holes subsequently being filled with expanding cement.

"Arrangement of groynes on a sandy beach" by Shositiro Nagai.

The author of this paper presents a study of the relationship between the velocity of long-shore currents caused by breaking waves and the steepness, length, period and angle of the waves to the shore line. From this theoretical and experimental work, recommendations are made for the effective arrangement of groynes for protection against beach erosion.

"Emploi de Ag 110 dans l'etude du transport du sable par la mer" by A. Gilbert.

In this paper M. Gilbert describes the work recently carried out by the Laboratorio Nacional de Engenharia Civil of Portugual to follow the movement of sand along the coast near Figueira da Foz. Silver 110 was used as the radioactive material and about 60 μc were attached by chemical precipitation to 100 kg. of sand which had been taken from near the point of injection. The activity was not sufficient for underwater detection, so samples of the bed were taken for examination in the laboratory. This involved extracting and concentrating the silver before measuring the activity. Ag 110 is a relatively cheap material and great accuracy is claimed for the determination of radioactivity, but the extraction and concentration of the silver is slow and expensive.

After the meetings in Lisbon, the participants made a 2-day tour of the regions to the north of Lisbon, visiting an irrigation scheme in the Lis valley and a hydro-electric scheme at Cabril. The dam at Cabril is of the thin-arch type, 132 m. in height, and the energy output of the power station is quoted at 260×10^6 kWh.

The proceedings of the Seventh Congress will be published in full by the Portuguese Organizing Committee in the near future, and copies will be obtainable from the I.A.H.R. Secretariat, Raam 61, Delft, Netherlands. The Eighth Congress will be held in Montreal in September 1959, when the subjects to be considered will include density currents and the fundamentals of the hydraulics of ship locks.

New Terminal for Australian Port.

The construction of a new overseas shipping terminal at Victoria Quay, Fremantle, is expected to begin in the near future. It is hoped to complete the building, a two storey structure, by 1959, in time for the commissioning of the new passenger liners on order for the P. and O. and Orient Companies.

Alumina Loader at Port Alfred, Quebec

(Specially Contributed)

At Port Alfred on the Saguenay River, Quebec which is 600 miles from the open sea, facilities have been developed for the handling of all kinds of outgoing and incoming cargo with a total capacity of some 3,000,000 tons a year. As the severity of the Canadian winter normally closes the port for practically five months of the year, activity at Port Alfred is sustained at a high level throughout the navigation season.

At present, the port facilities consist of three large wharves. The largest, Powell Wharf, is 1,342 ft. in length and the next, Duncan's Wharf is 950 ft. long. Three locomotive steam cranes, three electric travelling luffing cranes, four electric tower unloaders and four electric overhead cranes in the warehouse are installed at these berths where seven ocean-going vessels can be berthed at any one time—two discharging bauxite, one discharging fuel oil, two loading aluminium products and the other two loading newsprint, woodpulp and other local products.

The Roberval and Saguenay Railway, which is 19 miles in length, connects Port Alfred with the smelters at Arvida, carrying to the smelters the bulk of bauxite and other supplies which come into the Saguenay Valley. One of the shortest railways in Canada, but relatively one of the busiest, it handled in 1952 a total of 3,812,000 tons in approximately 2,200 trainloads. As much of the Saguenay aluminium moves over this system to the port, the railway has been a pioneer in the development of efficient and economical aluminium hopper and freight cars.

The principal shipping organisation serving the port is Saguenay Terminals, Ltd. Its history goes back to 1904 when the company was established originally to operate and maintain wharves at Port Alfred to facilitate the movement of local cargoes such as lumber, pulp and paper. The enterprise was later acquired by Aluminum Company of Canada, Limited (Alcan) and has since developed into one of Canada's largest shipping companies. Its development has been rapid since 1939 when only three ships were owned and, by 1952, the company owned eleven ships and had many others under charter.

Bauxite is delivered by ocean-going vessels to Port Alfred and from there it travels by rail to Arvida where the ore is processed so that the alumina may be extracted. This is either smelted into aluminium or transported to aluminium production centres in Europe, Canada and other parts of the world.

The high-speed handling of alumina at Port Alfred is a significant economic problem, in view of the comparatively short shipping season. Freight charges, which must include handling costs, represent a sizeable portion of the total cost of the metal. In a search for more efficient ways of loading alumina, a contract was awarded to Simon Handling Engineers, Ltd., Stockport, England, for the design and construction of a mechanical ship-loading travelling tower which would be capable of loading bulk alumina at the high rate of 300 short tons an hour. This plant, which is now in full operation, includes many features new to alumina loaders: the design is therefore of considerable interest and will be described in greater detail.

The plant has been erected on Powell Wharf and runs on existing crane rails. Here, allowance had to be made for the fact that the rail nearest to the water is some 23 ft. lower than the other rail and accordingly, the designers departed from the usual construction of travelling plants where all wheels are on the same level.

There is a fixed fluidised conveyor on the roof of a transit shed and it is from this that the loader picks up alumina. The spouts are at centres ranging from 35 ft. to 105 ft. along the conveyor and one of the spouts is connected to the loader by means of a flexible pipe with a quick-action coupling. In this way, alumina is passed into a second fluidised conveyor contained in the loader.

The fluidised conveyor is box-shaped in section, the lower half of which is made into a shallow closed trough by a porous medium on which rests the alumina. Compressed air is introduced into the trough from below, and this aerates the alumina so that it will flow down a slope which is only some five or six per cent of the conveyor length. The conveyor, its fan and motor and its supporting steel-work and platform can be raised from the normal working position when not in use so that trains can pass on the twin tracks on the quayside beneath. The conveyor and its accompanying equipment is slung in a cradle, suspended by wire ropes which are led over sheaves to a motor-driven winch, and it is raised and lowered through guide rails. From it the alumina falls into the boot of a bucket elevator, the design of which is of some interest because of its high working speed. It is a design which is commonly found in the many grain handling installations built by the same manufacturers.

Handling alumina by bucket elevator at a speed to meet the loader's rate of 300 short tons an hour presents some difficulties in design, on account of the nature of alumina which has a tendency not to discharge freely from the elevator buckets. To determine the best running speed for the Port Alfred bucket elevator, therefore, it was decided to carry out tests. Alumina was handled in a standard bucket elevator of small capacity at various belt speeds and with a variety of bucket shapes until optimum conditions were obtained.

The elevator finally evolved consists of a number of pressed steel

Aerial view of docking facilities at Port Alfred.

buckets which are attached to an indiarubber and canvas belt running over head and boot pulleys, the whole being enclosed entirely in dust-proof aluminium casing. The elevator is independently driven by motors and speed reducers and is fitted with retaining gear to prevent running back if stopped under load.

The buckets elevate the alumina from the boot which has a cast-iron pulley keyed to a mild steel shaft supported in self-aligning gun metal bushed sliding bearings which, together with the weights of the pulley shaft bearings and additional weights supply tension necessary for the belt to be driven. The elevator head is about 58 ft. above the boot, some 30 ft. higher than the control cabin and is housed in a machinery cabin. Its driving gear consists of a 25 h.p. electric motor driving a jack shaft through a fluid coupling mounted on a combination base plate and then through a chain drive to the worm shaft of a totally enclosed worm reduction unit which drives the head shaft through a flexible coupling. The worm shaft is extended and an electro-mechanical brake is fitted which is arranged so that if the current should fail, the brake will automatically be applied.

Provision is made for varying the speed of the elevator by changing the chain wheels, thus providing a simple means of correcting the discharge trajectory should the alumina change its character.

About half way along the return leg of the bucket elevator there is a cast-iron diverting pulley which keeps the belt at the correct tension and diverts it from the head pulley to the narrower boot

Alumina Loader at Port Alfred—continued

pulley.

The bucket elevator discharges into a small chute which feeds into a dock spout. The latter consists of three sections and at the top is hinged to, and supported by, a cast-iron ball-bearing turnhead which allows the spout to have both horizontal and vertical movement. The bottom sections of the spout are supported by wire ropes and shackles, which are suspended from a steel strut set into a ball and thrust bearing. The lower portion of the dockspout is telescopic and is reinforced by supporting guides. From the end of this is suspended a detachable hinged spout. The spouts are raised and telescoped by motor-driven winches independently controlled by push buttons. The speed of the winches is such that the spouts can be hoisted from the vertical position out to a slope of 40° to the horizontal in not more than three minutes, and the telescoping winch is capable of completing its travel in not more than two minutes. The range of the spout enables it to cover the length of a ship's hatch. All the spouts are made of aluminium alloy.

Exterior view of the new Unloader at Port Alfred.

The winch room is some 31 ft. above the quay and is level with the control room. The winches have cast-iron hoisting drums with sufficient grooves to coil the ropes in one layer. The traversing gear consists of four flanged wheels on two of which are bolted spur driving rings engaging with pinions, mounted on second motion shafts, which in turn are geared to a third motion shaft. The third motion shafts are driven by totally-enclosed worm gears with ball bearings and are driven by an electric motor through a flexible coupling which is used as an electro-mechanical brake. One of the flanged wheels is driven on the quay side and one on the elevated rail. The plant can travel along the quay at a speed of 80 ft. per minute.

Rail clamps have been provided at both ends of the structure on the wharf side. These are manually operated by hand wheels and screws and have a switch interlocked with the traversing circuit so that it is impossible to move the structure when the clamps are on. The brakes are completely enclosed and weatherproof. They are of the three-phase, solenoid electro-mechanical type and have dashpots. They are adjustable in each direction and are rated for continuous duty.

From the central control room one man can control the loader. He has a clear view of the ship's holds and can see whether or not the alumina is being distributed evenly. The structure has been constructed of steel and aluminium.

British Waterways Improvement Scheme

Further Details of Major Development Plan

From time to time during the past two years we have printed details of the £5½ million Development Plan for the British Waterways which is being carried out by the British Transport Commission. In our last month's issue we announced the improvements to be carried out on the South Western Division of the waterways and we now give below two further programmes which have recently been published by the Commission. These deal with two major waterways in the North Eastern Division; the Aire and Calder Navigation (£955,000), and the Sheffield and South Yorkshire Navigation (£593,250). These programmes are designed to enable these valuable water routes, which link the West Riding of Yorkshire, and the towns of Sheffield, Rotherham and Doncaster, with the ports of the Humber, to carry even further traffic. Over two-and-a-half million tons a year are at present carried on the Aire and Calder, and nearly a million tons, mostly coal, on the Sheffield and South Yorkshire waterway.

On the Aire and Calder Navigation the work to be carried out includes bank protection and navigation works, £591,500; mechanisation of locks, £70,000; dredging plant, etc., £67,000; workshops and other premises, £226,500.

On the Sheffield and South Yorkshire Navigation bank protection and navigation works will cost £369,000; mechanisation of locks, £15,000; dredging plant, etc., £209,250.

Aire and Calder Navigation.

Considerable bank protection work is to be carried out at a number of points throughout the high-embanked stretches of the Knottingley-Goole Canal section of the waterway. Steel and concrete piling will be used in this extensive work, which will safeguard the banks against the serious erosion caused by modern fast-moving powered craft. In order to facilitate this extensive pile driving programme, additional piling plant, comprising four piling rigs; three work boats, two of them motored; cranes; air compressors, etc., is to be obtained. An awkward right-angle bend at Leeds, near the Yorkshire Copper Works, which has made navigation difficult for large vessels, is to be eliminated and the northern bank reconstructed.

To speed the passage of craft on the heavily-used main route between Leeds and Goole, the locks are to be mechanised so as to permit gates and sluices to be operated simultanously; this will also eliminate the heavy manual labour now involved. The locks to be mechanised are: Knostrop Fall; Fishpond; Woodlesford; Lemonroyd, and Kippax (all between Leeds and Castleford); Bulhome (near Castleford, on the Knottingley side); Whitley, and Pollington (between Knottingley and Goole).

The dredging fleet on the Aire and Calder is to be modernised by the provision of a diesel bucket dredger, with retractable head and power driven winches, three self-propelled hopper boats, six steel general maintenance work boats, two steel pontoons for use in transporting excavators, and two excavators for discharging dredgings, drain cleaning, and heavy piling.

New buildings to be erected at Goole Repair Yard, the chief boat repair centre for the northern area of British Transport Waterways' North Eastern Division, include premises for compartment boats and blacksmiths' and engine shops. Modern plant and machine tools will be provided, and new roadways made. Also, the entrance is to be widened, the slipways improved and modern winches installed. New machinery will also be installed at Stanley Ferry Repair Yard, near Wakefield, on the Calder Cut Branch of the Navigation.

Sheffield and South Yorkshire Navigation.

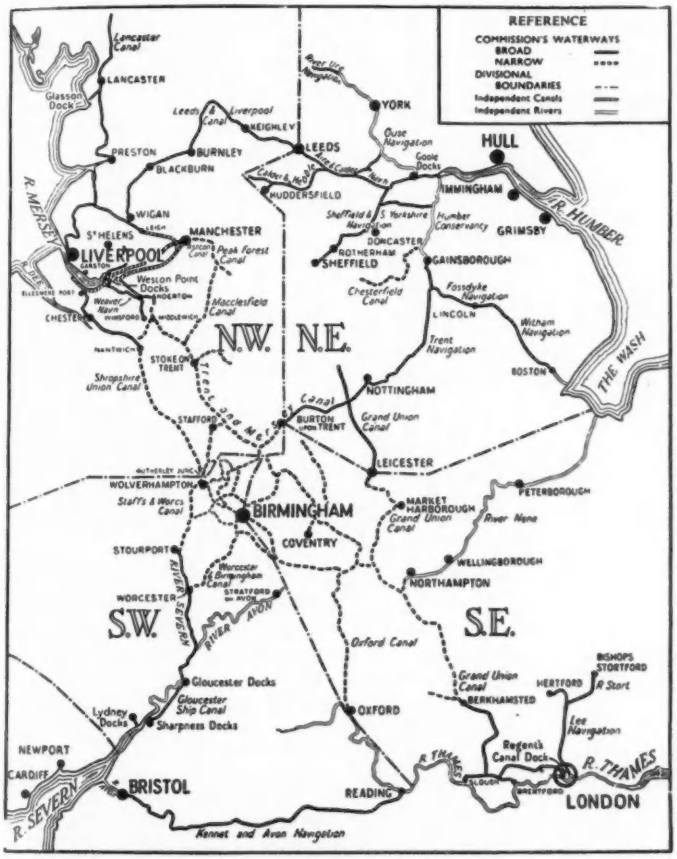
Major bank protection works are necessary on this waterway, and piling in steel and concrete is to be carried out along various lengths of the high-level sections between Sheffield and Mexborough, and between Doncaster and Keadby. Three piling rigs, two boats (one self-propelled), and other plant are to be purchased in connection with this pile driving programme.

The new lock now being constructed at Long Sandall near Doncaster and the Sykehouse Lock, on the New Junction Canal, are

British Waterways Improvement Scheme— continued

to be equipped with mechanical appliances to enable gates and sluices to be operated simultaneously.

It is proposed to augment and modernise the dredging fleet by the provision of four bucket-dredgers, with retractable heads and power driven winches, eight self-propelled steel hopper boats, three replacement steel pontoons for use in transporting excavators, four excavators for discharging dredgings, drain clearing, etc., and a diesel ice-breaking tug for the Sheffield-Keadby length. When not required for ice-breaking this craft will be used for general maintenance work.



Map of Inland Waterways in Great Britain, showing the Aire and Calder and Sheffield and South Yorkshire Navigations and their connection with the other waterways.

Present Facilities.

From Goole to Ferrybridge, a distance of about 18½ miles, the Navigation consists entirely of artificial canal. For five miles between Ferrybridge and Castleford it consists of the canalised River Aire. At Castleford it divides into two branches. One branch follows the line of the River Aire for about 10 miles to Leeds where it connects with the Leeds and Liverpool Canal. The other follows the line of the Calder to Wakefield for about eight miles, where it joins with the Calder and Hebble Navigation. The main line of navigation is also connected with the Sheffield and South Yorkshire Navigation by means of the 6-miles-long New Junction Canal. A further branch approximately 12-miles-long, consisting of both canalised River Aire and artificial canal, extends from the main route at Knottingley to the River Ouse at Selby.

The section from Goole to Leeds can accommodate craft carrying up to 250 tons but on the Castleford to Wakefield section the maximum is 170 tons. Coal in large quantities is conveyed in trains of compartment boats to Goole where it is tipped into seagoing ships. In addition, large tonnages pass from the collieries by barge to inland destinations for use at power stations and by industry. A considerable and increasing tonnage of petroleum products is carried in tank barges to inland storage depots, and there is also a substantial movement of general merchandise in both directions.

The Sheffield and South Yorkshire Navigation connects Sheffield, Rotherham and Doncaster to the Humber Ports. From its terminus at Sheffield to Keadby, where it joins the River Trent, it has a length of about 43 miles. There is also an important connection with the Aire and Calder Navigation by means of the New Junction Canal, a modern waterway six miles long built in the early years of the present century to give access to the port of Goole. The Navigation is a broad waterway which when the new lock at Long Sandall is completed will be navigable, via the New Junction Canal, as far as Hexthorpe (about a mile beyond Doncaster), by craft carrying up to 250 tons and also by the Commission's coal-carrying compartment boat trains. Over the remainder of its length to Sheffield the Navigation can accommodate craft of about 90 tons capacity.

The Cathodic Protection of Buoys

By I. D. G. GRAHAM, A.M.I.N.A., M.I.Mar.E.
(M. G. Duff & Partners Ltd., Cathodic Protection Division)

Before dealing with particular aspects of applying cathodic protection to navigational buoys it will be as well to consider briefly the extent of the problem involved, and assess in very round terms the benefits obtainable by the effective control of corrosion wastage and pitting. Cathodic protection is an electrochemical means of reversing the current flow in corrosion cells which are operating in a suitable electrolyte. The electrolyte in this case is water, primarily sea water. We are concerned therefore only with those surfaces of the shell of a buoy, and with its ancillary gear, which are immersed. Corrosion control on the above water parts of a buoy and of the internal shell must be dealt with by other means.

In practice corrosion control of the inside and of above water parts is reasonably well achieved by traditional means, but such measures are not of equally good effect below water; further, it is impracticable to afford any worth while protection to mooring gear by means of coatings. Cathodic protection therefore offers the possibility of effective corrosion control in exactly those parts of the buoy and its equipment where normal methods of protection are least efficient.

The effects of corrosion below water upon buoy maintenance and durability vary in different parts of the world, the rate of galvanic activity being effected by water salinity, temperature and other factors, and wastage being generally more rapid in tropical than in temperate or cold waters. But no area is without its corrosion problems. Whilst the advantages of effective underwater corrosion control may be greater in the Indian Ocean than in the English channel, they are far from negligible in the latter case. Further, there are in temperate waters certain areas where corrosive attack of buoy shell and mooring gear is, due to local conditions, virtually as rapid as in warm waters.

It is stated that in certain far eastern waters the average effective durability of a steel navigational buoy is only about eight years, and that even in this short life repairs to the underwater shell are required at the third to fifth year. At the end of this time the immersed parts are so wasted generally that either renewal or major re-building of the buoy is involved. The average working life of a buoy in home waters is not known and it will clearly be much longer, but it is known that repair costs are involved from time to time and that mooring gear requires frequent examination and renewal.

It is clear from the above that if the effective life of a buoy in any situation can even be doubled very material savings will accrue, and even more so if at the same time repair costs are reduced or even eliminated. It is therefore important to appreciate that cathodic protection properly applied can and does inhibit all underwater corrosion of the shell of a buoy, and in addition effects a very material reduction in corrosion wastage in the wind and water area immediately above the true waterline.

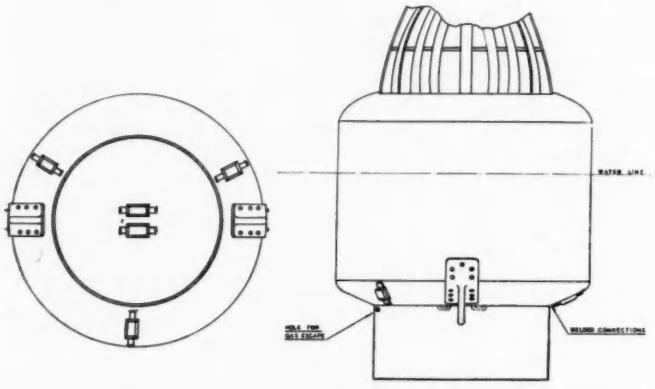
There are furthermore other savings; we may reasonably consider

The Cathodic Protection of Buoys—continued

that with control of underwater corrosion periodical descaling becomes unnecessary, and there will be savings in both painters' time and in painters' materials due to the smooth surface retained. Finally there is the important factor that period on station may be extended.

Full corrosion control for chain mooring gear is not yet possible though steady work is in hand to this end. Wire mooring gear can be given a high degree of protection without difficulty and it is for consideration whether more energetic attempts to introduce wire for this purpose should not be made. The objections normally raised are :

(a) Simple prejudice due to the known fact that steel wire as such without cathodic protection is very much less durable than chain cable.
(b) That the weight of a bight of mooring chain forms a valuable spring or shock absorber in bad weather and that wire will not perform this function.
(c) That wire will be more difficult to handle when lifting and laying.



It is not possible yet to guarantee one hundred per cent. protection of immersed steel wire, but the high degree of protection obtained is demonstrated in many existing cathodic protection systems applied to other structures, and by trials over the last two years carried out on the Sandhead Buoy in Chichester Harbour. In fact the life of an immersed and cathodically protected steel wire is enormously extended and becomes at least comparable to that of unprotected chain; further, apart from the envisaged saving on mooring gear renewals, wire is strength for strength very much less in initial cost than chain.

Objections (b) and (c) are practical ones deserving careful consideration. The weight factor however is hardly valid as an objection. There is no reason why a wire mooring should not be provided of the same weight as the chain, though in fact there is no evidence to show that this will prove necessary. Apart from this the shock strength of steel wires, section for section, is far greater than that of chain.

The handling of wire is admittedly more difficult in some respects so long as efforts are directed to handling it with the techniques and gear developed for handling chain cable. Surely it is not too much to suggest that some thought given to this matter would not overcome the difficulties Trawlermen manage the wire gear of their trawls without trouble, not once a year only but every working day of their lives. Admittedly the conditions are different, but equally the general awkwardness of wire for handling is clearly not in any sense an insuperable obstacle.

A word of warning as to inexpert application is perhaps not out of place. Galvanic anode materials such as are used for buoy protection have taken many years to develop, and the designs of the anodes themselves have been developed only after long research and trial. Beyond this the design of suitable protective schemes—as opposed to the design of the anodes themselves—is a matter demanding considerable experience and skill.

To obtain the best results the preparation of cathodic protection systems should be carried out by those who have, not only expert knowledge in general cathodic protection matters, but good experience of the particular type of scheme involved.

Coal Handling Plant at Gladstone

Australian Port's New Facilities

By J. GRINDROD

A coal handling and ship loading plant has recently been installed at the Port of Gladstone, which is situated some 300 miles north of Brisbane, Queensland, Australia. The equipment has been arranged to receive coal brought from the Callide field by road or rail and to deliver direct into colliers or into stock at a continuous average rate of 300 tons per hour. The plant has been installed by the Moore Conveyor Pty. Ltd., of Springvale, Victoria.

Arriving by rail and road the coal is dumped direct into adjacent track and road underground hoppers respectively, from which reciprocating plate feeders discharge to inclined 36-in. belt conveyor No. 1, which delivers at a height of about 20-ft. above ground to the centre point of the storage area.

If the coal is to be held in store at the port it is spread over the 15,000-ton capacity storage area by a drag scraper plant having a 4 cu. yd. scraper and an electrically-operated tail sheave car running on a curved track around the edge of the storage area.

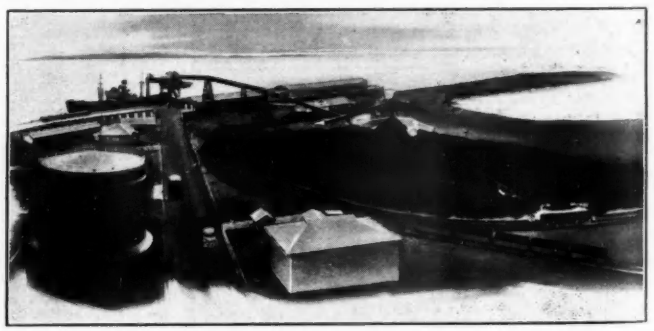
A ground level receiving hopper is also located at the centre point of the storage area. From this a reciprocating plate feeder discharges on to the long 36-in. belt conveyor No. 2 to the wharf.

When a collier is being loaded, coal being received at the port may be handled directly to the collier without going to storage, or coal may be reclaimed from storage by the drag scraper to the hopper at the centre point.

Belt conveyor No. 2 is 375-ft. in length and has a 70-ft. lift, the delivery end being supported on an elevated structure on the wharf. This conveyor delivers to a 36-in. belt shuttle conveyor of 75-ft. centres and with a 44-ft. travel movement. It also has a telescopic delivery chute which is lowered into the collier's hold after the shuttle conveyor has been moved out over the ship.

Coal is received and stored under the control of one operator located in an elevated cabin above the delivery end of belt conveyor No. 1. This operator has full control of the receiving hopper feeders, conveyor belt No. 1 and the drag scraper winch.

When a ship is being loaded, one additional operator is located in a cabin on the outer end of the shuttle conveyor, from which



Artist's impression of the new plant.

point he has full control of the storage area centre point hopper feeder, conveyor No. 2, the shuttle conveyor and the telescopic chute.

All sections of the plant are electrically operated, there being ten motors with a total of 300 h.p.

The Port of Gladstone is being extensively developed into a major port for ocean-going vessels. As well as being the shipping port for Callide coal, outward traffic includes meat and canned goods from a large works nearby, pyrites from Mt. Morgan mine, sorghum grain and other local products. Several large oil depots have been established and receive petroleum direct from overseas tankers.

Recent additions to the coal handling plant have been made for the handling of sorghum grain in bulk by the provision of a further belt conveyor which delivers to conveyor No. 2 and so to the ship.

Provision has also been made for extensions to make possible the loading of pyrites through the coal loading plant to the ship.

Manufacturers' Announcements

New Fork Lift Truck

The latest addition to the "Stacatruc" range of fork-lift trucks is a diesel powered machine, Model 624D, with a maximum capacity of 7,000 lbs. Features of the design are the rugged construction combined with ease of servicing and operation. One of the devices incorporated in the truck is a special constant mesh gearbox transmission system which provides two speeds forward and one reverse. This type of transmission has been introduced because of the need for two-pedal control and semi-automatic operation to help reduce driver-fatigue, to improve performance and to eliminate wearing parts. A similar system has been used with success on diesel railcars, where such a heavy duty necessitates smoothness of take up and minimum power losses.

The machine is powered by a 3.4 litre industrial diesel engine manufactured by the British Motors Corporation. The engine was introduced in 1954 to meet the demand for a medium power unit providing good low speed torque, long life between major overhauls, economy of fuel consumption, quietness and smooth running. As the B.M.C. has a world wide coverage the user is assured of spares and service facilities.

The design of the steering gear ensures that the steering is extremely light, particularly when the machine is mounted on cushion tyres. When pneumatic tyres are used powered steering is available if required.

The mast construction is conventional but the lifting ram has been specially designed to give a large amount of free-lift without resorting to the double stage ram usually associated with this feature. The mast generally is of robust construction and is operated by specially designed and produced Lockheed hydraulic gear. The standard forks are 6-in. wide by 2-in. thick by 42-in. long and are adjustable for overall width from 12-in. to 42-in.

The "Stacatruc" is manufactured by I.T.D. Ltd. of London.

Two-way Visual Inter-communication System

A new picture and sound transmission system, known as Deccafax, has been introduced by Decca Radar Limited.

Based on new applications of television receiver principles the system gives instant exchange of visual and sound information between inter-connected points on a closed circuit at distances of up to 2,000 yards. The distance may be increased with the help of amplifiers.

Communication is established by the use of a Master Unit connected by low loss co-axial cable to a second Master Unit. These units are small and compact enough for table use and the direction of the speech and picture transmission can be reversed by the operation of a switch. Pictures are transmitted by placing transparencies on the screen of the transmitting Master Unit, by using 35 mm. slides in a special projector built into the hood, or by writing information on the screen of the unit with a suitable pencil or pen. A facsimile image of the transmitted material appears instantly on the screen of the receiving Master Unit. Any number of units can be installed into the system if required.

For internal broadcasting the Master Unit can feed one or more, specially adapted, television receivers connected in the circuit. The receivers can still be used to receive normal programmes.

The versatility of Deccafax is of great interest. One important application of the system is to meet the requirements of information collation and filtering at centres where complicated visual displays are necessary, for example, Air Traffic Control Centres and Defence Operations Rooms. A number of remote Master Units can be inter-connected to feed different types of information on to a central receiver for enlargement on to viewing screen. Control can be exercised over the various inputs so that the main display shows only the specific information necessary at any one time. Filtering in this way makes it far easier for viewers to understand the significance of the events which concern them.

Considerable use could be made of the system for :- internal communication, with multiple extensions for factory, workshop, laboratory and works offices, hospitals, road transport organisations, and waiting rooms at shipping, airport and railway terminals

A number of applications are apparent in the sphere of dock and harbour working, both in passenger handling terminals and in docks employed solely for cargo handling operations.

At passenger terminals a single Master Unit could be employed to transmit messages, passenger information and announcements to a number of television receivers placed in waiting rooms and at prominent points in the building.

A constant check of cargo handling operations at a central office would be made possible by the provision of a number of units placed in warehouses and dockside offices. The system would enable a greater measure of control to be exercised over the flow of goods to and from vessels and would help in an appreciation of the state of loading or unloading.

Industrial Tractor for Dock Work

A further use for the Fordson Major Industrial Tractor has recently been demonstrated by Messrs. Convoys Ltd. at their London riverside premises. The tractor has been adapted to provide the power unit of a 30-cwt. crane, known as the "Hardy" diesel crane, which is employed in cargo handling and for warehouse operations such as stacking and loading.

30 cwt. crane, mounted on tractor, stacking rolls of paper.

Nine of these cranes mounted on Fordson tractors are now in daily operation and the designers believe that this new combination will fulfil all the main requirements of lifting height, hoisting speed, mobility, stability, and ease and economy of operation.

Over the past thirty years, this Company have constructed in their own workshops many different types of cranes mounted on tractors. They now contemplate marketing this latest machine as it appears to have other industrial and dockside applications.

Diesel Installation in Thames Tug

A Petter McLaren LE6 engine was recently installed in the tug "Caledonian" which is owned by Messrs. H. C. Green and Company of Milroy Wharf, London. The engine is a standard marine power unit developing 135 s.h.p. at 1,500 r.p.m. The transmission is through a hydraulically operated reverse gear box driving through 3 : 1 reduction gear which gives a propeller speed of 500 r.p.m. The cooling system is of the fresh water closed circuit method and a combined heat exchanger for fresh water and lubricating oil is incorporated. Raw water circulates round the heat exchanger and is passed on through the water cooled exhaust manifold and then overboard.

The LE6 engine is one of the engines in the Petter McLaren LE range manufactured by J. and H. MacLaren Limited of Leeds for industrial and marine application. They are obtainable in 4 and 6 cylinder form, normally aspirated, with power outputs ranging from 66 to 180 b.h.p. at 1,000 to 1,800 r.p.m.

APPOINTMENTS VACANT

SIERRA LEONE GOVERNMENT RAILWAY Port Management Branch require the folowing staff on contract for two tours of 18/24 months in the first instance. Outfit allowance £60. Free passages for officer and wife. Free passages for two children under age 19 or grant up to £150 annually for maintenance in U.K. Liberal leave on full salary.

(A) ASSISTANT PORT MANAGER (M3B/43901/DU). Salary (including Expatriation Pay) £1,857 a year. Gratuity at rate £150 a year. Candidates must have served in a responsible executive position in a port undertaking or in a shore working establishment of a large shipping organisation. They must have good all round experience of port operating and specialised experience of the assessment of rates and charges, port economics and accounting, statistics and modern office organisation and methods.

(B) QUAY SUPERINTENDENT (M3B/43902/DU). Salary (including Expatriation Pay) according to experience in scale £1,376 rising to £1,663 a year. Gratuity at rate £150 a year. Candidates preferably under 40, must have specialised experience of port traffic, and claims procedure (including accounts) and if possible a general experience of cargo handling. The officer appointed will be responsible under the Asst. Port Manager for the detailed working of the Traffic and Claims Office but may also be required on occasions to relieve outdoor operating Superintendents.
A Commision is considering a revision of these salaries.
Write to the Crown Agents, 4 Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote the reference number shown against the post desired.

NEW ZEALAND MINISTRY OF WORKS
PROFESSIONAL AND TECHNICAL STAFF

The Ministry of Works, New Zealand, invites applications for the following vacancies on the Permanent Staff. Positions, qualifications desired and commencing salaries are as follows:

CIVIL ENGINEERING DIVISION.

1. ENGINEERS. Corporate Membership of the Institution of Civil Engineers, London. Commencing salaries from £895 to £1,465 per annum.

2. ASSISTANT ENGINEERS. A University degree in Civil Engineering which gives exemption from final Parts I and II of the A.M.I.C.E. examination or an equivalent examination. Commencing salaries from £810 to 1,000 per annum.

3. ENGINEERING ASSISTANTS. General Certificate of Education standard or equivalent, and eight years' practical experience. Commencing salaries £810 to £1,080 per annum.

4. DRAUGHTSMEN. Ordinary or Higher National Certificate or equivalent and at least three years' experience at the drawing board. Commencing salary up to £1,150 per annum in accordance with qualifications and experience.

Enquiries mentioning this paper and quoting reference No. 3/74/133, also stating type and number of position sought, should be addressed to the High Commissioner for New Zealand, 415 Strand, London, W.C.2. Full details of duties, experience desired, and general information on the conditions of employment in the New Zealand Public Service, together with application forms will then be furnished.

PUBLIC SERVICE OF SOUTH AUSTRALIA

Applications for the undermentioned position should be made in writing to the Agent-General for South Australia, South Australia House, Marble Arch, London, W.1, setting out full names, address, date of birth, marital status, academic qualifications, practical experience, and particulars of war service (if any). Copies of testimonials and photograph should be submitted with the application. Closing date 14th October 1957.

CHIEF ENGINEER, HARBOURS BOARD DEPARTMENT
(RE ADVERTISED)

Salary: £3,053 per annum. Applications are invited for the position of Engineer of the South Australian Harbours Board, a State Ports Authority charged with the administration, development and maintenance of the deep sea ports of Adelaide, Pirie, Wallaroo, Lincoln and Thevenard and also 50 minor outports.

Qualifications. Applicants should be holders of approved University degrees in engineering, or corporate members of the Institution of Civil Engineers, London, or Institution of Engineers, Australia, who have specialised in port and harbour engineering.

Duties, The Chief Engineer will be responsible for an engineering organisation at present numbering approximately 260 staff and 900 other employees, undertaking the design, construction and maintenance of engineering works and port installations. These include wharves and piers in reinforced concrete, steel and timber; retaining walls in steel sheetpiling and reinforced concrete; piled foundations, steel framed transity sheds and port buildings generally; the mechanical equipment of wharves including electrically operated wharf cranes for general and heavy duty; electric power and lighting; major bulk coal and grain handling installations; breakwaters and earthworks. He will also be responsible for a fairly large dockyard engineering establishment; the maintenance and operation of a considerable fleet of dredgers, tugs, barges and other floating plant; the execution of major dredging and reclamation works; the installation and maintenance of aids to navigation; and the use and upkeep of a wide range of construction plant.
Administrative capacity of a high order and ability to lead and co-ordinate the work of other qualified engineers are essential qualifications. The Chief Engineer is directly responsible to the General Manager, who is due to retire in March, 1961.

BRITISH TRANSPORT WATERWAYS require ENGINEERING ASSISTANT (CIVIL) at Leeds. Applicants should have good practical experience in the design, execution and maintenance of civil engineering works. Knowledge of river or marine works would be an advantage. Preference to corporate members of the Institution of Civil Engineers. Salary range £900/£945 per annum. Certain privilege rail travel facilities. Superannuation fund. Applications stating qualifications, experience and present salary, to be addressed to the Staff and Establishment Officer, 163 Euston Road, London, N.W.1, not later than the 21st September, 1957.

FOR SALE

GREENOCK HARBOUR TRUST
35-ton Electric Travelling Portal Crane

The Trustees of the Port and Harbours of Greenock have for sale as it stands on the site on the Coaling Jetty, James Watt Dock, Greenock, a modern electric Travelling Portal Crane, as built and delivered by Messrs. George Russell & Co. Ltd., of Motherwell, in 1944. The Crane is of the fixed jib Portal Carriage Type designed to lift 35 tons at a radius of 60 feet at a speed of 57 feet per minute to a height of 85 feet measured from rail level to jib-head pulley. The Crane tracks are at 40 feet centres spanning three railway lines for coaling operations and a through type cradle with automatic locking mechanism is provided.
The Prime Mover is a 230 h.p. auto-synchronous motor, with Ward Leonard Generator and Control for 180 h.p. main hoist motor and 90 h.p. tipping motor. Slewing is by a 60 h.p. S.R. motor giving a speed of 400 feet per minute at jib-head; travelling on 16 double R.S. tyred wheels is by four 12½ h.p. S.R. motors at a speed of 72 feet per minute. The crane is wired for a 440 volts, 3 phase, 50 cycle supply; "Igranic" D.C. type "M" Brakes on hoisting and tipping motions; limits on all motions except slewing; controls fully interlocked; lighting and heating throughout; instruments for indicating incoming volts and amps, Amps Ward Leonard Loop, Exciter volts D.C., Exciter Amps A.C., and Power Factor Meter.
The structural and mechanical arrangements are by Messrs. George Russell and Co. Ltd.; motors by Crompton Parkinson, and controls by Igranic and Ellison. The crane is in perfect condition throughout and can be examined by representatives of prospective buyers by arrangement with the subscriber. Offers marked "Tender for 35 tons Electric Travelling Portal Crane" should be lodged with the Undersigned not later than noon Monday, 14th October, 1957. The Trustees do not bind themselves to accept the highest or any tender.

Harbour Offices,
Greenock.

DONALD SMITH,
General Manager and Engineer.

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